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NEW OR NOTEWORTHY PHILIPPINE ORCHIDS, III

By OAKES AMES
Professor of Botany in Harvard University
and
EDUARDO QUISUMBING
Botanist, Bureau of Science, Manila

TWENTY-EIGHT PLATES

The third paper of this series is essentially like its predecessors, the last number of which was published in February, 1932.[1] The present paper contains the descriptions of six hitherto undescribed species and one variety, with notes and redescriptions of *Dendrochilum Weberi, Gastrochilus calceolaris,* and *Microsaccus Wenzelii,* as well as a record and description of one species (*Cymbidium pubescens*) previously described from extra-Philippine material now found for the first time in the Archipelago. All the illustrations and the descriptions in the text have been prepared from living plants. The colored illustrations and ink sketches were made by Messrs. J. M. Salazar and P. Ramos, draftsmen of the division of botany, Bureau of Science. Plates 11 and 12 were executed by F. Guerrero, a draftsman of the same division. All the types of the new species and varieties have been deposited in the herbarium of the Bureau of Science, with the isotypes in the herbarium of the senior author. Available isotypes will be distributed to the herbarium of the New York Botanical Garden and other herbaria.

[1] Philip. Journ. Sci. 47 (1932) 197.

Genus COELOGYNE Lindley

COELOGYNE REMEDIOSAE sp. nov. § Flexuosæ. Plates 1, 3, and 14.

Radices glabrae, plus minusve 2 mm in diametro, carnosae et pallidae ut videtur. Rhizoma 8 ad 10 mm in diametro. Pseudobulbi in serie, anguste cylindracei, 11 ad 13 cm longi, 2 ad 2.7 cm in crassitudine infra medium, utrinque attenuati, diphylli, in rhizomate crasso repenti 2 ad 3 cm inter se distantes; juniores vaginis membranaceis, obtusis vel acutis, usque ad 7 cm longis vestiti. Folia cum petiolo 22.5 ad 26 cm longa, 5.5 ad 8.5 cm lata, elliptico-oblonga vel elliptica, breviter acuminata, subtus prominenter quinquenervia. Scapus initio foliis juvenilibus synanthus, 23 ad 31.5 cm longus, basi nuda, pauciflorus; rhachis gracilis, erecta vel arcuata. Bracteae inflorescentiae ignotae. Flores succedanei. Pedicellus cum ovario circiter 1.5 cm longus. Sepala lateralia oblonga, abrupte acuta vel subacuta, 2.5 ad 2.9 cm longa, 1.0 ad 1.3 cm lata, subcarnosa. Sepalum dorsale oblongo-lanceolatum, acutum, 2 ad 2.2 cm longum, 0.8 ad 1.0 cm latum. Petala linearia, obtusa, apice obliquo apiculata, 2.5 ad 2.6 cm longa, 2.5 ad 3 mm lata, erecta. Labellum subcarnosum, trilobatum, circiter 2.5 cm longum; lobis laterales breves, subquadrati, apice valde obtusati vel rotundati, parte libera circiter 3 mm longa; lobus intermedius in circuitu suborbicularis, circiter 1.5 cm longus, 1.5 cm latus, apice subrotundatus, minute apiculatus, margine undulato; discus carinis 2, antice altis ornatus, ad basim 5-carinatus. Columna valde arcuata, carnosa, circiter 1.8 cm longa, apicem versus alata.

Roots glabrous, fibrous, about 2 mm in diameter, straw-colored. Rhizomes creeping, 8 to 10 mm in diameter. Pseudobulbs in linear series, narrowly cylindric, 11 to 13 cm high, 2 to 2.7 cm in diameter, tapering at both ends, diphyllous, 2 to 3 cm distant. Sheaths membranaceous, obtuse or acute, up to 7 cm long. Leaves with petiole 22.5 to 26 cm long, 5.5 to 8.5 cm wide, elliptic-oblong or elliptic, acute, conspicuously 5-nerved beneath. Scapes terminal, arising between the leaves of the immature pseudobulbs, the base naked, few-flowered, 23 to 31.5 cm long; rachis slender, erect or curved at the top. Bracts of the inflorescence early deciduous, not seen. Flowers odorless, produced in succession. Pedicellate ovary about 1.5 cm long, the ovary ridged. Lateral sepals oblong, abruptly acute or subacute, 2.5 to 2.9 cm long, 1.0 to 1.3 cm wide, somewhat fleshy. Dorsal sepal oblong-lanceolate, acute, 2 to 2.2 cm long, 0.8 to 1.0 cm wide. Petals linear, obtuse, minutely apiculate at the oblique

apex, erect, 2.5 to 2.6 cm long, 2.5 to 3 mm wide. Labellum somewhat fleshy, trilobed, about 2.5 cm long; lateral lobes rather short, subquadrate, the apex broadly obtuse or rounded, free portion about 3 mm long; middle lobe suborbicular, about 1.5 cm long, 1.5 cm wide, apex subrounded with a minute apicule, the margin undulate; disc with 5 low keels at the base, two of the keels increasingly high, conspicuous and wavy toward the apex, extended to one-third or one-half of the middle lobe; the 3 short basal keels 3 to 3.5 mm long. Column about 1.8 cm long, arcuate, fleshy, conspicuously winged at the apex.

LUZON, Manila, cultivated in the gardens of Mrs. Remedios C. Gonzales, *Bur. Sci. 82232 Quisumbing*, February 24, 1931. The plants flowered again a month earlier in Mrs. Gonzales's gardens this year (1932). The living plants, purchased from a peddler, were of uncertain origin but they were surely Philippine. The sepals are sea-foam yellow and deep sea-foam green at the middle; the petals are sea-foam green; column glass green, the apical margin pale grass green; the labellum marguerite yellow except the lamellæ, lateral lobes and the markings at the center of the middle lobe snuff brown.[1]

Among the known Philippine coelogynes, this species appears most closely related to *C. marmorata* Reichb. f., but differs in its longer scape and in the keels of the lip. In habit it suggests *C. bilamellata* Lindl., *C. candoonensis* Ames and *C. longirachis* Ames, but it has much larger flowers and a dissimilar lip.

Genus DENDROCHILUM Blume

DENDROCHILUM WEBERI Ames § Eudendrochilum. Plates 1, 4, and 15.

Dendrochilum Weberi AMES in Philip. Journ. Sci. 8 (1913) Bot. 410, Orch. 5 (1915) 65.

Rhizoma elongatum, repens, gracile, 2 ad 2.5 mm in diametro, ad nodos radicans. Pseudobulbi anguste cylindracei, 2 ad 3 cm longi, 2 ad 5.5 cm distantes. Folia breviter petiolata, coriacea, oblongo-lanceolata vel peranguste elliptica, in sicco nervosa, 7 ad 8.5 cm longa, 1 ad 2 cm lata, utrinque attenuata, ad apicem acuta. Scapus lateralis in basi pseudobulbi, plus minusve foliis longior, 8 ad 11 cm longus, gracilis, flexuosus vel pendulus, ad basim vaginis tubularibus bracteiformibus inclusus; bracteis inflorescentiae glabris, lanceolatis, usque ad 2 mm longis. Flores in

[1] The color terms used are mostly from Ridgway's Color Standards and Color Nomenclature (1912).

racemis laxis dispositi. Sepala lateralia lineari-lanceolata, subacuta, circiter 5 mm longa, 1.25 mm lata, 3-nervia, levissime falcata. Sepalum dorsale lineari-lanceolatum, acutum, circiter 5 mm longum, 1.5 mm latum, 3-nervium. Petala lineari-oblanceolata, obtusa vel acuta, circiter 4 mm longa, 1 mm lata, 1-nervia. Labellum obovato-oblongum, medio utrinque leviter angustatum, ad apicem late rotundatum vel retusum, circiter 2 mm longum, 1 mm latum, 3-nervium, ad basim bicallosum; pars inferior abrupte reflexa. Columna brevis, ad apicem trilobatam dente medio bidentato, dentibus lateralibus erectis, triangulari-linearibus. Pollinia quatuor.

Rhizomes creeping, elongated, slender, 2 to 2.5 mm in diameter, copiously rooting at the nodes. Roots fibrous, branching. Pseudobulbs narrowly cylindric, 2 to 3 cm long, rugose when dry, 2 to 5.5 cm apart. Leaves shortly petioled, coriaceous, oblong-lanceolate or very narrowly elliptic, 7 to 8.5 cm long, 1 to 2 cm wide, tapering at both ends, the apex acute; petioles 2 to 4 mm long. Scapes commonly longer than the leaves, 8 to 11 cm long, slender, flexuose or pendant, arising from the base of the pseudobulbs, sheathed at base with several tubular bracts. Bracts subtending the flowers lanceolate, acute, concave, up to 2 mm long. Flowers marguerite yellow, laxly disposed on the racemes. Lateral sepals linear-lanceolate, subacute, about 5 mm long, 1.25 mm wide, 3-nerved, slightly falcate. Dorsal sepal linear-lanceolate, acute, about 5 mm long, 1.5 mm wide, 3-nerved. Petals linear-oblanceolate, obtuse or acute, about 4 mm long, 1 mm wide, 1-nerved. Labellum glabrous, obovate-oblong, in the middle on each side slightly narrowed, reflexed at the base, about 2 mm long, 1 mm wide, broadly rounded or retuse at the apex, the base subhastate and bicallose, 3-nerved. Column very short, arcuate, at the apex trilobed, the middle tooth bidentate, the lateral arms triangular-linear and suberect. Pollinia 4.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 84546 Quisumbing*, May 19, 1931. The living plants were collected by Messrs. M. Ramos and P. Convocar from near the banks of Camahalan River, Agusan Province, Mindanao, growing on rocks, April 30, 1931. Living specimens are now growing on the tuff (Guadalupe stone) walls in the Bureau of Science orchid house in Manila.

This is the third collection of this species. In general habit it very closely resembles *D. aurantiacum* Blume, but differs in the details of the flowers.

Genus AGROSTOPHYLLUM Blume

AGROSTOPHYLLUM SACCATILABIUM sp. nov. Plates 1, 5, 16, and 17.

Aff. *A. inocephalum* (Schauer) Ames. Planta glabra, ad basim foliis discessis, nuda, supra foliosa, 32 ad 45 cm alta. Caules complanati, vaginis foliorum tecti. Folia disticha, anguste lineari-oblonga; lamina 12 ad 17 cm longa, 2 ad 3 cm lata, in sicco subcoriacea, obtusa; vaginae foliorum imbricatae, persistentes, flavidae et atromarginatae, longivaginantae, usque ad 5 cm longae. Inflorescentiae terminalis, densissime capitata, usque ad 3.5 cm in diametro. Flores albidi, parvi, in racemis paucifloris numerosissimis capitulum formantes, bracteis imbricatis subtendentibus, 4 ad 6 mm in diametro. Sepala lateralia carinata, cucullata, ovato-oblonga, subacuta, circiter 4 mm longa, 2 mm lata, 3-nervia. Sepalum dorsale ovatum, subacutum, 3-nervium, circiter 3.5 mm longum, 2.25 mm latum. Petala lineari-lanceolata, apice ipso paulo ampliata, circiter 3.5 mm longa, 0.75 mm lata. Labellum saccatum, in circuitu suborbiculare; parte inferiore (hypochilio) semiorbiculari, saccata, circiter 1.5 mm longa; parte terminali (epichilio) valde saccata, semiorbiculari, ad apicem rotundata, circiter 2.5 mm longa; callus transversus. Columna crassa, circiter 2 mm longa. Pollinia 8.

A glabrous epiphyte, rather stout, 32 to 45 cm high; stems tufted, flattened, narrowed at the base. Leaves restricted to the upper portion of the stems, distichous, jointed with persistent clasping rigid bases; lamina 12 to 17 cm long, 2 to 3 cm wide, narrowly linear-oblong, obtuse, when dry subcoriaceous; sheaths up to 5 cm long. Inflorescences terminal, capitate, pluribracteate, up to 3.5 cm in diameter. Flowers very numerous, in few-flowered racemes, very crowded, marguerite yellow, 4 to 6 mm across. Lateral sepals carinate, cucullate, ovate-oblong, subacute, about 4 mm long, 2 mm wide, 3-nerved, the two side nerves not reaching the apex. Dorsal sepal ovate, subacute, about 3.5 mm long, 2.25 mm wide, 3-nerved. Petals linear-lanceolate, about 3.5 mm long, 0.75 mm wide. Labellum saccate, suborbicular in outline, about 3 mm long; hypochile semiorbicular, saccate, about 1.5 mm long, separated from the epichile by a transverse callus; epichile saccate, semiorbicular, the apex broadly rounded, about 2.5 mm long. Column stout, about 2 mm long. Pollinia 8.

LUZON, Benguet Subprovince, Baguio, Gardens of the Mansion House, *Bur. Sci. 82229 Quisumbing*, May 6, 1931. The living plants were first seen in the gardens of the Mansion House at

Baguio; the origin of the specimens is not known, but we are assured that the orchid peddlers in Baguio collected them from the mountains in the vicinity of Baguio.

A species closely allied to *Agrostophyllum inocephalum* (Schauer) Ames, but differing radically in the shape of the epichile.

Genus DENDROBIUM Swartz

DENDROBIUM AURICULATUM sp. nov. Plates 1, 6, and 18.

Aff. *D. papilio*. Caulibus simplicibus, basibus foliorum auriculatis, floribus albidis et basi auriculata labelli plus ovati differt.

Stems numerous, crowded in a clump, 30 to 82 cm high, erect or suberect, not branched, terete, greenish yellow, 1.5 to 3 mm in diameter; internodes up to 2.5 cm long. Leaves linear-lanceolate, the apex narrowed, acute, unequally bilobed with the subulate lobules 1 to 2 mm long, the base prominently auricled with the lobules extending across the stems, the lamina 8 to 12.5 cm long, 4 to 8 mm wide, somewhat rigid; the sheaths tubular, purplish. Flowers odorless, showy, appearing singly on the naked termination of the stems, 6 to 6.5 cm across. Flowering stems usually defoliated (if leaves are present when the plant is in flower, only the apical ones remain). Pedicellate ovary slender, 1.8 to 2 cm long. Sepals and petals pure white, lined at the base with purple. Lateral sepals oblong-lanceolate, obtuse, including the spur 4 to 4.1 cm long, obtuse, greenish and lined with purple. Dorsal sepal oblong, obtuse, 2.5 to 2.6 cm long, 1 to 1.1 cm wide at the widest portion, 7-nerved. Petals obliquely oblong-elliptic, obtuse, 2.5 to 2.7 cm long, 1.1 to 1.2 cm wide, 5-nerved. Labellum conspicuously unguiculate, simple; claw linear, the lower third tubular saccate, 1.9 to 2 cm long, conspicuously green, lamina (when expanded) broadly ovate-cordate, obtuse, margins minutely dentate or crenate-dentate, membranaceous, 2 to 2.1 cm long, 1.5 to 1.6 cm wide, with three obscure central lines throughout, pure white. Gynostemium very short and stout, clinandrium tridentate with the central tooth linear-subulate, extended into a long foot, including the foot 1.9 to 2 cm long. Anther oblong-ovoid, obtuse, about 3 mm long, 2 mm wide.

In the herbarium of Oakes Ames is a plant from Mindanao representing this species. It differs from the typical specific form in its conspicuously smaller flowers of which the petal is 1.5 cm long and about 6.5 mm wide and the entire lip, including the claw, about 2.5 cm long. Its data are Mindanao, District

of Davao, Divide on Apo Ridge, altitude 3,050 feet. Epiphyte. Flowers white. *C. M. Weber 246*, August 25, 1911.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 84542 Quisumbing*, March 11, 1931. The living plants were collected from the mountains near the source of Angat Irrigation System, Bulacan Province, growing on rocks. The plants flowered for the second time earlier (January, 1932).

A very interesting orchid and worthy of a place in orchid gardens. The species doubtless is closely allied to *Dendrobium papilio* Loher, but differs in its unbranched stems, leaves with conspicuously auricled bases, and the pure white flowers, purple-lined at the bases of petals and sepals, with green throat and claw. The margins of the labellum are minutely dentate. The plants thrive well in earthen pots with tuff and humus.

DENDROBIUM GUERREROI sp. nov. Plates 1, 7, 19, and 20.

Aff. *D. O'Brieno* et *D. amethystoglosso*. Caules aggregati, elongati, suberecti, basi attenuati, 30 ad 76 cm longi, usque ad 8 mm in diametro. Folia lanceolata vel oblongo-lanceolata, 7.5 ad 10.5 cm longa, 1.6 ad 2.5 cm lata, apice attenuata, acuta, membranacea. Racemi penduli, pauci et laxiflori, usque ad 8 cm longi, 10- ad 13-flori, e caulibus defoliatis orientes. Flores 3 ad 3.3 cm longi, 2 ad 2.2 cm lati. Sepala lateralia oblique oblong-lanceolata, acuta, 13.5 ad 14 mm longa, 7.5 ad 8.5 mm lata, 7-nervia, mentum formantia; mentum elongatum, saccatum, superne rectum vel leviter curvatum, obtusum, circiter 1.5 cm longum. Sepalum dorsale oblongo-lanceolatum, subacutum, 13 ad 15.5 mm longum, 5 ad 6 mm latum, 7-nervium. Petala oblongo-elliptica, obtusa, 14 ad 15 mm longa, 6 ad 7 mm lata, 5-nervia. Labellum simplex, elongatum, 25 ad 27 mm longum, basi unguiculata lineari, in positu naturali complanatum, cum pede gynostemii connatum; lamina ovata, 15 ad 17 mm longa, expansa 12 ad 13 mm lata, margine levissime crenulata vel integerrima, antice late rotundata vel leviter retusa, plus minusve apiculata; discus fascia una elevatula carnosa praeditus. Gynostemium brevissimum, crassum, tridentatum; stelidia lateralia recurvata, lata, obtusa, dens medius tenuis, linearis. Anthera ovoidea, circiter 2 mm longa.

Stems terete, aggregated, elongate, suberect, 30 to 76 cm long, up to 8 mm in diameter at the widest portion, narrowed at the base. Leaves distichous, deciduous, lanceolate or oblong-lanceolate, 7.5 to 10.5 cm long, 1.6 to 2.5 cm wide, nervose, membranaceous, greenish, when young flushed with purple, narrowed

to the acute apex, articulated to tubular sheaths. Leaf-sheaths purplish when young, otherwise green, membranaceous, deciduous on the lower part of the plant. Racemes pendulous, few- and laxly flowered, up to 8 cm long. Flowers 10 to 13, 2 to 2.2 cm across, 3 to 3.3 cm long, with rather straight or slightly inflexed spur. Bracts pellucid, minute, triangular, acute, up to 3.5 mm long, white flushed with purple. Pedicellate ovary 1.5 to 2.5 cm long, rose purple, pedicel slender. Lateral sepals obliquely oblong-lanceolate, acute, somewhat cucullate at the tip, 13.5 to 14 mm long near the posterior margin, 7.5 to 8.5 mm wide, 7-nerved, forming with the column-foot a mentum or spur which is elongate, straight or slightly curved, obtuse, about 1.5 cm long. Dorsal sepal slightly cucullate with the tip bent forward, oblong-lanceolate, subacute, 13 to 15.5 mm long, 5 to 6 mm wide, 7-nerved. Petals spreading, oblong-elliptic, obtuse, 14 to 15 mm long, 6 to 7 mm wide, 5-nerved, margin entire. Labellum simple, elongate, 25 to 27 mm long, claw linear, flattened, attached to the foot of the column, lamina ovate, 15 to 17 mm long, 12 to 13 mm wide at the widest portion (when expanded), the apex broadly rounded or slightly retuse, with a very minute mucro in the notch, the margin entire or finely crenulate; disc provided with a single broad central fleshy keel which is glabrous and extends from the column-foot nearly to the apex of the lip. Column white, very short and stout, 2 to 2.5 mm long, extended into an elongated foot. Anther ovoid, about 2 mm long.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 84541 Quisumbing*, July 27, 1932. The living plants were originally gathered by the botanical collectors Maximo Ramos and Pascual Convocar, of the Bureau of Science, in May, 1931, from Dinagat Island, near Mindanao. The plants are now being cultivated in the Bureau of Science orchid house, and this description was based on specimens which flowered in Manila on July 25, 1931. The flowers are showy and odorless, and last for two or three days. Pedicellate ovary rose purple; sepals naphthalene yellow, usually flushed with rose purple on the back (older flowers become cream-colored); petals paler, marguerite yellow; spur primrose yellow with shades of honey yellow at the tip and flushed on the back with rose purple; column-foot primrose yellow and minutely dotted with rose purple; gynostemium and anther white; labellum chamois and minutely dotted within (particularly at the throat) with rose purple except the tip which

is marguerite yellow, and the raised disc rosolane pink which extends from the column-foot to the very lip.

A species doubtless belonging in the group with *Dendrobium O'Brienum* Kränzl. and *Dendrobium amethystoglossum* Reichb. f. It is especially close to the first but differs in its much shorter and few-flowered racemes, in the spur, and especially the labellum.

This species is dedicated to Dr. Leon Ma. Guerrero, chief of the division of botany of the Bureau of Science and specialist in Philippine medicinal plants. The junior author greatly appreciates the encouragement Doctor Guerrero has given him during the prosecution of these studies.

Genus CYMBIDIUM Swartz

CYMBIDIUM PUBESCENS Lindl. Plates 2, 8, 21, and 22.

Cymbidium pubescens LINDL. Bot. Reg. 26 (1840) Misc. p. 75, *27* (1841) *t. 38;* J. J. SM. Fl. Buitenzorg. 6 (Orch. Java) (1905) 483, Fig.-Atlas (1911) *fig. 368;* SCHLECHTER, Die Orchideen (1927) 362.

Cymbidium aloifolium BLUME Bijdr. (1825) 378.

Cymbidium bicolor LINDL. (p. p.) Gen. & Sp. Orch. (1833) 164; MIQ. Fl. Ind. Bat. 3 (1859) 707; REICHB. F. Walp. Ann. 6 (1863) 625.

"*C. pubescens;* foliis ensiformibus striatis apice oblique bidentatis, racemo brevi pendulo, bracteis minimis squamaeformibus, sepalis petalisque linearibus acutiusculis, labelli trilobi basi saccati intus pubescentis laciniis lateralibus acutis intermedia oblonga subundulata obtusa, lamellis rectiusculis medio interruptis." Bot. Reg. 26 (1840), misc. p. 75, no. 177. Lindl. 27 (1841) *t. 38.*

An epiphyte, much the habit of *Cymbidium atropurpureum* (Lindl.) Rolfe. Leaves clustered, coriaceous, sessile, dark green, ligulate-linear, 50 to 53 cm long, 1.75 to 1.9 cm wide, striated, apex very obliquely notched. Racemes pendulous, 5- to 10-flowered, 15 to 25 cm long, arising from the sides of the base; the peduncles glabrous, about 11.5 cm long, 4 mm in diameter, clothed at the base with 3 tubular sheaths; the sheaths light green, the basal ones shortest, oblong (when expanded), acute, about 3 cm long, 2 cm wide, the two upper ones linear-lanceolate, acute, 4 to 4.5 cm long, about 1.5 cm wide. Floral bracts minute, squamiform, triangular, acute, 2.5 to 3 mm long. Pedicellate ovary 1.3 to 1.5 cm long. Flowers odorless, about 3 cm across. Lateral sepals spreading, narrowly oblong or slightly oblanceolate, acute, slightly oblique, 1.5 to 1.7 cm long, 5 to 5.5 mm wide, 7-nerved. Dorsal sepal similar, erect. Petals

spreading, lanceolate or elliptic-lanceolate, acute, 1.4 to 1.55 cm long, 4.75 to 5 mm wide, 5-nerved. Labellum trilobed, suborbicular-ovate in outline when expanded, saccate at the base, minutely ciliate on both surfaces, more so within and on the margins; lateral lobes semiovate with free apices, short, triangular, porrect, acute, 3 to 3.5 mm long; middle lobe broadly oblong to suborbicular, 7 to 7.5 mm long, 5.5 to 6.25 mm wide, the apex rounded, recurved, apiculate at the very tip; the disc with a pair of subparallel fleshy lamellæ or ridges at the base in front of which stands another pair of smaller calli. Column long, arcuate, without a foot, slightly thickened at the apex, 10 to 11.5 mm long. Anther semiglobose. Pollinia 2, complanate-pyriform.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 84547 Quisumbing,* January 13, 1931. The living plants, which are now in cultivation in the Bureau of Science orchid house, were collected near Butuan, Agusan Province, Mindanao, growing on trees at low altitudes. The sepals and petals etruscan red or acajou red broadly edged with deep colonial buff; lateral lobes of the labellum ivory yellow dotted with ox-blood red; middle lobe of the labellum naples yellow and tipped with ox-blood red. Column pompeian red; anther light orange yellow above and amber brown below.

Lindley, Bot. Reg. 27 (1841) *t. 38,* states—"Although the woods of Sincapore have been so often examined by Botanists it seems as if the forms of vegetation there were inexhaustible. The species now figured was met with by Mr. Cuming who sent it to Messrs. Loddiges." This species, which is distributed over Malay Peninsula, Sumatra, and Java, and Banca and Siam, fide Ridley, doubtless belongs in the group with *C. finlaysonianum* Lindl. and *C. atropurpureum* (Lindl.) Rolfe. It has the general habit of *C. atropurpureum* and resembles it in the form and size of leaves, but is distinct from both species in having very much shorter racemes, smaller flowers, and pubescent labellum as well as in the color of the flowers. *Cymbidium pubescens* Lindl. is here for the first time reported from the Philippines, although several sterile and fruiting specimens in the herbarium of Oakes Ames perhaps represent it. The plant thrives best in orchid pots with crushed tuff as a substratum or in wooden baskets. The cymbidiums of the Philippines are some of the most hardy of orchids and they even grow luxuriantly perched on branches of trees.

Genus SARCOCHILUS R. Brown

SARCOCHILUS BENGUETENSIS sp. nov. Plates 1, 9, and 23.

Herba epiphytica, carnosa. Caules leviter elongati, 8 ad 13 cm longi, teretes, radices crassas proferentes. Folia disticha, valde carnosa, rigida, oblonga vel elliptico-oblonga, obtusa, 6 ad 8 cm longa, 1.8 ad 2.3 cm lata, ad apicem inaequaliter biloba, in sicco rugosa, coriacea, 6 ad 12 mm distantia, vaginis persistentibus. Inflorescentiae breves, foliis multo breviores, usque ad 3 cm longae, pedunculus glaber, usque ad 1.2 cm longus; rhachis inflorescentiae leviter incrassata, 2 ad 3 mm in diametro; bracteae squamiformes, circiter 4 mm longae, obtusae. Flores odoratissimi, in racemo cylindraceo laxo pauciflora dispositi, 10.5 ad 11 mm lati; pedicellus cum ovario gracilis, 6 ad 7 mm longus; bracteae florales minutae, triangulares, acutae, usque ad 2 mm longae. Sepala lateralia oblique late ovata, obtusa ad apicem dorso leviter carinata, circiter 4 mm longa, 3.5 ad 3.75 mm lata, 3-nervia. Sepalum dorsale cucullatum, oblongo-ovatum, obtusum, leviter retusum, circiter 4 mm longum, 2.75 latum, 3-nervium. Petala oblongo-lanceolata vel elliptico-lanceolata, valde obtusa, uninervia, circiter 3.75 mm longa, 1.25 mm lata. Labellum pedi columnae affixum, calcaratum, 3-lobatum; lobi laterales erecti, petaloidei, lineares, obtusi, circiter 2.75 mm longi, 0.75 mm lati; lobus intermedius carnosissimus, abbreviatus, papillosus. Calcar supra lobum medium cylindraceo-conicum, complanatum, late obtusum, circiter 4 mm longum, 2 mm latum. Gynostemium brevissimum, circiter 1.5 mm longum, in pedem circiter 2.5 mm longum extensum.

An epiphytic herb; the stems somewhat elongated, 8 to 13 cm long, terete. Leaves distichous, very fleshy, rigid, oblong or elliptic-oblong, obtuse, 6 to 8 cm long, 1.8 to 2.3 cm wide, unequally and minutely bilobed at the apex, when dry rugose and coriaceous, 6 to 12 mm distant, articulated to persistent sheaths. Inflorescences much shorter than the leaves, few-flowered, up to 3 cm long; the peduncles glabrous, up to 1.2 cm long; the rachis 2 to 3 mm in diameter, provided with squamiform obtuse bracts about 4 mm long. Flowers very fragrant, 10.5 to 11 mm across; pedicellate ovary slender, 6 to 7 mm long; floral bracts minute, triangular, acute, up to 2 mm long. Lateral sepals broadly ovate, very oblique, obtuse, keeled on the back at the apex, about 4 mm long, 3.5 to 3.75 mm wide, 3-nerved. Dorsal sepal cucullate, oblong-ovate, obtuse, somewhat retuse, about 4 mm long, 2.75 mm wide, 3-nerved. Petals oblong-lanceolate or elliptic-

lanceolate, broadly obtuse, 1-nerved, about 3.75 mm long, 1.25 mm wide. Labellum attached to the foot of the column, spurred, 3-lobed; lateral lobes erect, petaloid, linear, slightly curved, obtuse, about 2.75 mm long, 0.75 mm wide; middle lobe a short fleshy, conical, papillose tooth; spur cylindric-conic, dorsoventrally flattened, about 4 mm long, 2 mm wide, the tip broadly rounded or subtruncate. A pair of minute uncinate lobules stand inside the base of the lateral lobes. Gynostemium very short, about 1.5 mm long, extended into a foot about 2.5 mm long. Pollinia 4, complanate-ovoid, unequal.

LUZON, Benguet Subprovince, Baguio, gardens of the Mansion House, *Bur. Sci. 82203 Quisumbing*, May 6, 1931. The living plants were originally from the mountains near Baguio, but the exact locality is unknown. At present the living plants are growing in the Bureau of Science orchid house. Sepals and petals white dotted with purple-red; labellum white except the inner surfaces of the lateral lobes which are dotted with purple-red; anther yellow; back side of the column carmine; pedicellate ovary marguerite yellow.

Among the Philippine species, this plant appears to be allied to *Sarcochilus palawanensis* Ames but differs strikingly in its short racemes and in the dissimilar form of the perianth segments.

Genus PHALAENOPSIS Blume

PHALAENOPSIS LUEDDEMANNIANA Reichb. f. var. PURPUREA var. nov. Plates 2, 10, and 24.

Haec varietas floribus omnino purpureis haud striatis a *P. Lueddemanniana* differt.

Plant suberect. Leaves oblong-elliptic to narrowly obovate, thick, fleshy, slightly rigid, subacute, 8.5 to 14 cm long, 4.5 to 6 cm wide, shining on both surfaces. Scapes not branching, few-flowered; rachis 10.5 to 13.5 cm long. Flowers odorless, about 3.5 cm across, true purple and absolutely without transverse bars on the sepals and petals in front, and obscurely reticulated with white on the back. The tips of sepals are white. Pedicellate ovary white, 3 to 3.5 cm long. Lateral sepals obliquely ovate, acute, apiculate, 1.9 to 2.2 cm long, 1 to 1.3 cm wide (when spread out), 9-nerved. Dorsal sepal erect, elliptic-lanceolate, acute and apiculate, 1.9 to 2.2 cm long, about 0.9 cm wide, 9-nerved. Petals oblong-elliptic, subobtuse, 1.8 to 2 cm long, 0.8 to 0.9 cm wide, 7-nerved. Labellum fleshy, 3-lobed; lateral lobes erect, quadrate-oblong, bidentate at the broad apex, with a

prominent fleshy callus above the middle, about 7 mm long, light orange except the terminal horns which are mallow pink and the base which is white; middle lobe lanceolate or oblong-lanceolate, obtuse, 1.4 to 1.5 cm long, 0.6 to 0.7 cm wide at the widest portion. Disc provided with several distinct calli: near the base, between the side lobes, an obscurely 3-lobed plurituberculate callus; at the base of the middle lobe a pair of slender sharp teeth and a longer thin high median keel which extends to the middle of the terminal lobe where it is continued by irregular teeth and terminates in a fleshy callus (toothed or fringed at the base) which extends to the apex of the lip. Column 1 to 1.3 cm long, white with a mallow pink base.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 84550 Quisumbing*, June 6, 1931. The living plants were presented to the junior author by Mr. Constinoble, of Del Carmen, Pampanga Province, Luzon, who collected them at Balete Pass, Nueva Ecija Province, Luzon, growing on tree trunks.

The variety is characterized by the complete absence of transverse bars on the sepals and petals. It further differs from the species in its smaller floral segments and leaves.

Genus GASTROCHILUS D. Don

GASTROCHILUS CALCEOLARIS D. Don. Plates 2, 11, and 25.

Gastrochilus calceolaris D. DON, Prodr. Fl. Nep. (1825) 32.

Saccolabium calceolare LINDL. in Wall. Cat. No. 7302, Gen. & Spec. Orch. (1833) 223; Sert. Orch. Frontisp. (1838) No. 6, in Bot. Reg. (1838) Misc. p. 75, No. 139, in Journ. Linn. Soc. 3 (1859) 33; GRIFF., Notul. 3 (1851) 356, Itin. Notes (1848) 170, No. 869, Ic. Pl. Asiat. 3 (1851) *t. 334;* REICHB. f. in Walp. Ann. 6 (1864) 883; HOOK. f., Fl. Brit. Ind. 6 (1890) 60; KING and PANTL. in Ann. Roy. Bot. Gard. Calcutta 8 (1898) 225, *t. 300;* J. J. SM., Fl. Buitenzorg (Orch. Jav.) (1905) 632, Fig.-Atlas (1908) *t. 472* (as *Gastrochilus*).

Aërides calceolare SM. in Rees. Cycl. (1819) Addend. & Corrigend.

Aërides leopardinum WALL. apud Lindl., Sert. Orch. (1838) No. 6, *in synon.*

Gastrochilus sororius SCHLTR. in Fedde. Repert. 12 (1913) 315.

Sarcochilus nepalensis SPRENG. Syst. Veg. 3 (1826) 721.

Epidendrum calceolare BUCH.-HAM. apud D. Don, Prodr. Fl. Nep. (1825) 32, *in synon.*

Gastrochilus philippinensis AMES, Orch. 5 (1915) 231, in MERR. Enum. Philip. Fl. Pl. 1 (1925) 434.

GASTROCHILUS. *Labellum* ventricoso-inflatum, sessile, indivisum, apice appendice rotundatâ papilloso-glandulosâ erosè crenatâ auctum. *Perianthii foliola* omnia distincta, subaequalia, patula. *Columna* brevissi-

ma. *Massae pollinis* 2, integrae, sessiles, apici stigmatis adnatae. Herba *arboribus parasitica.* Caudex *brevis, radicans, erectus.* Folia *lineari-lanata, 5–7 pollices longa, 3–5 lineas lata, coriacea, enervia, plana, glabra.* Scapi *brevissimi, ex inferiore caudicis ortum ducentes, vix ibidem aequantes, pluri* (3–5)*-flori.* Pedunculi *patuli, uniflori.* Flores *facie fere* Cypripedii *at minimi.* Perianthii foliola 5, *distincta, obovata, subaequalia.* Labellum *valde ventricosum, foliolis brevius, margine rectum, anticè appendiculatum.*

Obs. Nomen ἀγκαδνῆ, *venter,* et χλωρός, *labium;* id est *labium ventricosum.*

1. G. calceolaris.

Epidendrum calceolare. *Hamilton MSS.*

Hab. ad Narainhetty Nepalensium, *Hamilton, Wallich.* Floret Februario." Ex. D. Don, Prodr. Fl. Nep. (1825) 32.

"16. *Saccolabium calceolare. Lindl. in Wall. Cat. No. 7302.*

S. subacaule, foliis loratis acuminatis apice obliquè bidentatis, corymbis multifloris breviter pedunculatis, sepalis petalisque obovato-oblongis obtusis, labelli calcare inflato orbiculato; laminâ lunatâ rotundatâ ciliatâ.

Gastrochilus calceolaris *Don Prodr. Nep. 32.* Aeridis calceolare, *Smith in Rees. suppl.* Hab. in *Nepalia* et *Sylhet,* Wallich. (*hab. s. sp. e Mus. Angl. Ind. et v. ic. pict.*). Folia 9 p. longa, basi maculata. Sepala et petala flava, maculis, subrotundis purpureis notata. Labellum album; laminâ basi luteo et coccineo punctatâ." Ex. Lindl., Gen. & Sp. Orch. (1833) 223.

Stems pendulous, about 8 cm long, up to 6 mm in diameter. Roots terete, up to 18 cm long, 3 to 3.5 mm in diameter. Leaves distichous, the lower ones imbricated, light green, oblong, oblong-elliptic, or oblanceolate, narrowed to the very unequally bilobed apex, 14 to 16 cm long, 2.5 to 2.8 cm wide, submembranaceous when dry. Racemes short, corymbose, 3 to 3.5 cm long, 8- to 10-flowered, peduncles green spotted with dark brown, stout and fleshy, 1.3 to 1.5 cm long, provided at the base with two short tubular sheaths which are 3 to 4 mm long. Floral bracts cucullate, ovate, obtuse, rigid, up to 3.5 mm long. Pedicellate ovary reed yellow, 7 to 8 mm long, lined with green. Flowers odorless, crowded, about 1.5 cm across. Sepals and petals fleshy, reed yellow to olive yellow spotted with chocolate on the sepals and brick red on petals. Sepals oblong-obovate, obtuse, about 7 mm long, 4 mm wide at the widest portion. Petals narrower, obovate-spatulate. Labellum 5 to 5.5 mm long, adnate to the lower half of the column, basal portion forming a conical, obtuse sac, 5 to 5.5 mm deep, white blotched with mallow pink, the very tip cream color; lateral lobes inconspicuous, erect; middle lobe subreniform, 3 to 4 mm long, 6 to 7 mm wide, margins deeply and unequally fimbriated, upper surface, except for a V-shaped zinc orange basal callus covered with white hairlike papillæ. At

the center of the callus there is a naples yellow ridge. Column very short, stout, white flushed with pink. Anther somewhat flattened, shortly beaked, chartreuse yellow. Pollinia ellipsoid.

LUZON, Manila, Miyasaki Gardens, *Bur. Sci. 82231 Quisumbing,* February 7, 1931. The living plants were collected from Baguio, Benguet Subprovince by Mr. S. Miyasaki, an orchid grower, and are now in cultivation in his gardens. The first Philippine specimen was collected by A. D. E. Elmer 6517 (type of *G. philippinensis* Ames) in Baguio, June 28, 1904. The species has also been reported from Sikkim and the Khasia Hills, Java, Sumatra, and Assam.

After a careful study of this Philippine material, it has been found necessary to reduce *G. philippinensis* Ames to synonymy as the characters relied on for specific distinction have proved to be unreliable.

Genus VANDOPSIS Pfitzer

VANDOPSIS DAVISII sp. nov. Plates 2, 12, 26, and 27.

Herba valida, 20 ad 60 cm alta. Radices elongatae, brunneae, glabrae. Caules teretes, vaginiis foliorum omnino tecta, 1.2 ad 1.5 cm in diametro. Folia disticha, ligulata, valde rigida, falcato-decurvata, 1.5 ad 3.5 cm distantia, ad apicem inaequaliter bilobata cum lobis obtusis, medio canaliculata, 16 ad 39 cm longa, 2.3 ad 3.5 cm lata (in sicco valde coriacea haud nervosa), valde rugosa. Pedunculus 13 ad 14.5 cm longus, 4 ad 5 mm in diametro, rigidus, glaber, erectus. Inflorescentiae racemosae, 10- ad 14-florae, erectae. Pedicellus cum ovario albidus, 2 ad 2.5 cm longus, rigidus, glaber. Bracteae inflorescentiae squamiformes, breves, ovatae, cucullatae, circiter 3 mm longae; bracteae caulinae tubulares, 3 ad 4 mm longae. Flores albido-virides, 2.2 ad 2.4 cm lati, 3.2 ad 3.3 cm longi, carnosi. Sepala breviter unguiculata. Sepala lateralia ovato-elliptica, obtusa, circiter 1.5 cm longa, 7 mm lata. Sepalum dorsale ovato-oblanceolatum, obtusum, circiter 1.6 cm longum, supra medium 7 mm latum. Petala oblanceolata, obtusa, circiter 1.4 cm longa, 5.5 ad 6 mm lata. Labellum trilobatum, base valde saccata, circiter 1.1 cm longum; lobi laterales parvi, erecti, triangulares, circiter 2 mm alti, late rotundati, carnosi, utrinque glabri; lobus medius multo major, carnosus, lateraliter compressus, rigidus, in circuitu (supra visus) ovato-lanceolatus, circiter 7 mm longus, subtus prominenter carinatus, supra minutissime pubescens, apice truncatus. Carina transversa suborbicularis valde concava in basi saccata stat. Gynostemium breve, crassum, circiter 6 mm longum gla-

brum, ad apicem biconnutum. Anthera glabra. Pollinia 4, subaequalia. Capsula ellipsoidea, valde saccata, 6 ad 6.5 cm longa, 1.7 ad 1.8 cm in diametro.

A very coarse herb, 20 to 60 cm high, recalling *Sarcanthus pachyphyllus* Ames. Roots elongate, brown, glabrous. Stems terete, coarse, very rigid, usually erect, sometimes curved, altogether concealed by the tubular leaf-sheaths, 1.2 to 1.5 cm in diameter. Leaves distichous, ligulate, 16 to 39 cm long, 2.3 to 3.5 cm wide, very rigid, very thickly leathery, falcate-decurved, in texture approaching those of *Sarcanthus pachyphyllus*, 1.5 to 3.5 cm distant, unequally bilobed at the apex with obtuse lobes, channelled through the middle (when dry very coriaceous and never nerved), very rugose. Peduncles erect, rigid, 13 to 14.5 cm long, 4 to 5 mm in diameter, glabrous. Inflorescences in the upper part of the peduncle, racemose, 10- to 14-flowered, erect. Pedicellate ovary white, 2 to 2.5 cm long, rigid, glabrous, twisted at the base. Bracts of the inflorescence squamiform, short, ovate, cucullate, about 3 mm long. Flowers fragrant, fleshy, firm, 2.2 to 2.4 cm across, 3.2 to 3.3 cm long. Sepals shortly clawed. Lateral sepals ovate-elliptic, obtuse, about 1.5 cm long, 7 mm wide. Dorsal sepal ovate-oblanceolate, obtuse, about 1.6 cm long, 7 mm wide about the middle. Petals oblanceolate, obtuse, about 1.4 cm long, 5.5 to 6 mm wide. Labellum trilobed, conspicuously saccate at the base, about 1.1 cm long; lateral lobes small, erect, triangular, about 2 mm high, broadly rounded, fleshy, glabrous on both surfaces; middle lobe much larger, fleshy, laterally compressed, in outline (when seen from above) ovate-lanceolate, rigid, about 7 mm long, prominently carinate beneath, very minutely pubescent above, truncate at the apex. At the saccate base of the labellum (between the lateral lobes) there is a small transverse, suborbicular, deeply concave keel as in *Staurochilus ionosma*. Gynostemium short, stout, about 6 mm long, glabrous, 2-horned at the apex with falcate horns. Anther glabrous. Pollinia 4, subequal. Capsules ellipsoid, 6 to 6.5 cm long, 1.7 to 1.8 cm in diameter, prominently 3-keeled (between each keel there are two shallow ridges).

LUZON, Manila Bureau of Science orchid house, *Bur. Sci. 82228 Quisumbing*, March 31, 1931. The living plants, according to orchid peddlers, were originally collected from the mountains near Montalban, Rizal Province, Luzon. They are now in cultivation in the Bureau of Science orchid house, Miyasaki Gardens, and Mrs. Remedios C. Gonzales's gardens, all in Ma-

nila. Rachis of the inflorescence greenish; pedicellate ovary white; sepals and petals white on back and front washed with lumiere green or light lumiere green, and spotted and barred with claret brown on the petals and raw umber on the sepals; lateral lobes of the labellum pale viridine yellow; middle lobe of the labellum white; spotted with ox-blood red above, on both sides of the keel above and empire yellow at the very tip of the tongue; callus at the base of the labellum between the lateral lobes cuplike, white, light orange yellow within.

In habit this unique species suggests *Sarcanthus pachyphyllus*, especially in the very rigid, thick, keeled, falcate leaves, but it differs radically in floral characters. In floral structure it is very much like *Vandopsis lissochiloides* (Gaudich.) Pfitz., but its flowers are much smaller and of different color.

This very interesting species is dedicated to Hon. Dwight F. Davis, for his interest in orchids and particularly for his unselfish devotion and interest in his work when Governor-General of the Philippines.

Genus MICROSACCUS Blume

MICROSACCUS WENZELII Ames. Plates 1, 13, and 28.

Microsaccus Wenzelii AMES Orch. 5 (1915) 257, in Merr. Enum. Philip. Fl. Pl. 1 (1925) 442.

Planta pusilla, epiphytica. Radices in basi caulium. Caules dependentes (?) usque ad 1 dm. alti, circiter 3 mm. in crassitudine, cum foliis usque ad 4 cm. lati, vaginis foliorum persistentibus obtegentibus: internodia brevia vaginis omnino tecta, 3 mm. longa. Folia biseriata, patentissima, equitantia, crasse carnosa, lateraliter compressa, oblonga a latere visa, dorso et apice acutangula, obtusa sed a basi sensim angustata, in sicco valde rugosa, usque ad 2 cm. longa, circiter 5 mm. alta, supra canaliculata. Inflorescentiae axillares, brevissimae, 1 (-2) florae. Pedunculus folii vaginis aequilongus. Bracteae ovatae vel orbiculares, valde concavae, extus leviter carinatae, membranaceae, usque ad 5 mm. longae. Flores parvi, albi. Sepala lateralia leviter falcata, obtusa, extus, prope apicem, carinata, trinervia, vix 5 mm. longa, 2 mm. lata. Sepalum dorsale sepalis lateralibus minus, ad apicem cucullatum et incrassatum vel carinatum, 4 mm. longum, 1.5 mm. latum, trinervium. Petala oblongi-lanceolata, uninervia, obtusa, 3 mm. longa, 1 mm. lata. Labellum calcaratum, spathulatum vel cuneato-obovatum, ad apicem obscure trilobatum, in disco bicallosum. Lamina incrassata cum calcari 7 mm. longa, ad apicem 3 mm. lata. Calcar circiter 2 mm. longum, scrotiforme, emarginatum. Gynostemium brevissimum. Fructus 7 mm. longus.

Epiphyte. Stems curved in maturity, the base terete, leafless, but covered with remnants of sheaths, the apical portion foliose, up to 11.5 cm long. Roots fibrous, numerous. Leaves con-

spicuously and densely distichous, equitant, imbricating, sessile, lanceolate, obtuse, decreasing but little in size toward the apex, the largest up to 2 cm long, 6 mm wide, rigid, leathery, thick, flattened, rugose when dry; internodes very short. Flowers small, white, single in the axils of the leaves, about 8 mm across. Pedicellate ovary very slender, about 1.5 mm long, entirely covered by imbricated, triangular, acute bracts which are 3.5 to 4 mm long. Lateral sepals obliquely elliptic, slightly falcate, obtuse, about 5 mm long, 2.5 mm wide. Dorsal sepal narrowly oblong, obtuse, about 5 mm long, 1.75 mm wide, 3-nerved. Petals oblong-lanceolate, obtuse, about 4 mm long, 1.5 mm wide. Labellum simple, obovate, fleshy, about 4 mm long, obscurely trilobed, apex expanded, 2 mm wide, subacute, the very apex thickened beneath. Spur short, flattened, emarginate, about 2.5 mm long. Column very minute, about 1 mm long.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 82230 Quisumbing,* January 24, 1931. The living plants were originally gathered by Mr. Maximo Ramos, botanical collector of the Bureau of Science, at Quezon National Park, Tayabas Province, growing on tree trunks. LEYTE, Dagami, *C. A. Wenzel, 0159, 029,* October 25, 1912 (type).

This species is closely related to *Microsaccus brevifolius* J. J. Sm., differing in habit and in the form of the sepals and petals.

ILLUSTRATIONS

Plate 1

Fig. 1. *Microsaccus Wenzelii* Ames, front view of a flower, × 2.
2. *Microsaccus Wenzelii* Ames, side view of a flower, × 2.
3. *Coelogyne Remediosae* sp. nov., front view of a flower, × 1.
4. *Coelogyne Remediosae* sp. nov., side view of a flower, × 1.
5. *Agrostophyllum saccatilabium* sp. nov., front view of a flower, × 4.
6. *Agrostophyllum saccatilabium* sp. nov., side view of a flower, × 4.
7. *Dendrobium Guerreroi* sp. nov., front view of a flower, × 1.
8. *Dendrobium Guerreroi* sp. nov., side view of a flower, × 1.
9. *Dendrobium auriculatum* sp. nov., front view of a flower, × 1.
10. *Dendrobium auriculatum* sp. nov., side view of a flower, × 1.
11. *Dendrochilum Weberi* Ames, front view of a flower, × 4.
12. *Dendrochilum Weberi* Ames, side view of a flower, × 4.
13. *Sarcochilus benguetensis* sp. nov., front view of a flower, × 2.
14. *Sarcochilus bneguetensis* sp. nov., side view of a flower, × 2.

Plate 2

Fig. 1. *Gastrochilus calceolaris* D. Don, front view of a flower, × 2.
2. *Gastrochilus calceolaris* D. Don, side view of a flower, × 2.
3. *Gastrochilus calceolaris* D. Don, view of column, anther and labellum from above, × 4.
4. *Cymbidium pubescens* Lindl., front view of a flower, × 1.
5. *Cymbidium pubescens* Lindl., side view of a flower, × 1.
6. *Phalaenopsis Lueddemanniana* Reichb. f. var. *purpurea* var. nov., front view of a flower, × 1.
7. *Phalaenopsis Lueddemanniana* Reichb. f. var. *purpurea* var. nov., side view of a flower, × 1.
8. *Vandopsis Davisii* sp. nov., front view of a flower, × 1.
9. *Vandopsis Davisii* sp. nov., side view of a flower, × 1.
10. *Vandopsis Davisii* sp. nov., front view of ovary, column and labellum, × 2.
11. *Vandopsis Davisii* sp. nov., side view of column and labellum, × 2.

Plate 3

Coelogyne Remediosae sp. nov.: *1*, dorsal sepal, × 2; *2*, lateral sepal, × 2; *3*, petal, × 2; *4*, labellum and column from above, × 2; *5*, side view of column and labellum, × 2; *6*, front view of column, × 2; *7*, view of anther from above, × 17; *8*, view of anther from below, × 17; *9*, side view of anther, × 17; *10*, two pollinia, × 17.

PLATE 4

Dendrochilum Weberi Ames: *1*, dorsal sepal, × 16; *2*, lateral sepal, × 16; *3*, petal, × 16; *4*, view of column and labellum from above (natural position), × 28; *5*, side view of column and labellum, × 28; *6*, view of labellum (expanded) from above × 36; *7*, front view of column, × 28; *8*, views of anther from above and from below, × 36; *9*, pollinia, × 28.

PLATE 5

Agrostophyllum saccatilabium sp. nov.: *1*, a spike showing floral bracts and buds, × 4; *2*, a floral bract, × 15; *3*, dorsal sepal viewed from within, × 12; *4*, lateral sepal viewed from without, × 12; *5*, outer view of petal, × 12; *6*, side view of column, and labellum, × 12; *7*, view of labellum from above (in natural position), × 12; *8*, front view of column with the labellum removed, × 12; *9*, view of anther from above, × 34; *10*, pollinia, × 52.

PLATE 6

Dendrobium auriculatum sp. nov.: *1*, portion of the stem with leaves, × 0.5; *2*, detail of the base of the leaf and its attachment, × 2; *3*, dorsal sepal, × 1; *4*, lateral sepal, spur, and pedicellate ovary, × 1; *5*, petal, × 1; *6*, view of column and labellum from above (natural position), × 1; *7*, view of labellum (expanded) from above, × 1; *8*, side view of ovary, column, spur, and labellum (natural position), × 1; *9*, front view of column with foot, × 2; *10*, side view of pedicellate ovary, column, and spur with lateral sepals removed, × 2; *11*, view of anther from above, × 6; *12*, view of anther from below, × 6; *13*, pollinia, × 6.

PLATE 7

Dendrobium Guerreroi sp. nov.: *1*, dorsal sepal, × 2; *2*, lateral sepal and pedicellate ovary, × 2; *3*, petal, × 2; *4*, side view of ovary, column, and labellum, × 2; *5*, front view of column and labellum (natural position), × 2; *6*, view of (extended) labellum from above, × 2; *7*, side view of ovary and column with anther, × 4; *8*, front view of column with foot, × 4; *9*, view of anther from above, × 12; *10*, view of anther from below, × 12; *11*, two pollinia, × 12.

PLATE 8

Cymbidium pubescens Lindl.: *1*, dorsal sepal, × 3; *2*, petal, × 3; *3*, lateral sepal, × 3; *4*, view of column and expanded labellum from above, × 4; *5*, side view of portion of ovary, column, and labellum, (natural position), × 4; *6*, view of anther from above, × 15; *7*, view of anther from below, × 15; *8*, pollinia, × 30.

PLATE 9

Sarcochilus benguetensis sp. nov.: *1*, dorsal sepal, × 12; *2*, lateral sepal, × 12; *3*, petal, × 15; *4*, side view of column, labellum and spur, × 12; *5*, view of labellum with side lobes expanded from above, × 8; *6*, front view of column and anther, × 15; *7*, view of anther from below, × 28; *8*, pollinia, × 28.

PLATE 10

Phalaenopsis Lueddemanniana Reichb. f. var. *purpurea* var. nov.: *1*, dorsal sepal, × 2; *2*, petal, × 2; *3*, lateral sepal, × 2; *4*, view of column and labellum from above (natural position), × 4; *5*, view of labellum (expanded) from above, × 4; *6*, side view of column and labellum (natural position), × 4; *7*, views of anther from below and from above, × 5; *8*, pollinia, × 6.

PLATE 11

Gastrochilus calceolaris D. Don: *1*, dorsal sepal, × 4; *2*, petal, × 4; *3*, lateral sepal, × 4; *4*, side view of column and labellum, × 7; *5*, view of column and labellum from above, × 7; *6*, view of anther from above, × 15; *7*, view of anther from below, × 15; *8*, two pollinia, × 28.

PLATE 12

Vandopsis Davisii sp. nov.: *1*, dorsal sepal, × 3; *2*, petal, × 3; *3*, lateral sepal, × 3; *4*, side view of portion of ovary, column with anther and labellum, × 5; *5*, front view of column, and labellum, × 5; *6*, view of labellum from above with the lateral lobes slightly expanded, × 5; *7*, view of anther from above, × 15; *8*, view of anther from below, × 15; *9*, pollinia, × 15; *10*, fruit, × 1.

PLATE 13

Microsaccus Wenzelii Ames: *1*, habit of the plant with one flower, × 1; *2*, dorsal sepal, × 7.5; *3*, lateral sepal, × 7.5; *4*, petal, × 7.5; *5*, side view of ovary, column, and labellum, × 7.5; *6*, view of spur, column with anther removed, and labellum from above, × 7.5; *7*, view of anther from above, × 13; *8*, view of anther from below, × 13; *9*, pollinia, × 11.

PLATE 14

Coelogyne Remediosae sp. nov.: habit, very much reduced, and flower, reduced.

PLATE 15

FIG. 1. *Dendrochilum Weberi* Ames: habit, very much reduced.
2. *Dendrochilum Weberi* Ames: flowers and portion of plant, very slightly enlarged.

PLATE 16

Agrostophyllum saccatilabium sp. nov.: habit, very much reduced.

PLATE 17

Agrostophyllum saccatilabium sp. nov.: inflorescence and leaf-bases, slightly enlarged.

PLATE 18

FIG. 1. *Dendrobium auriculatum* sp. nov.: habit, very much reduced.
2. *Dendrobium auriculatum* sp. nov.: flower, slightly enlarged.

PLATE 19

Dendrobium Guerreroi sp. nov.: habit, very much reduced.

PLATE 20

Dendrobium Guerreroi sp. nov.: flowers, slightly reduced.

PLATE 21

Cymbidium pubescens Lindl.; habit, very much reduced.

PLATE 22

Cymbidium pubescens Lindl.; flowers and raceme, almost natural size.

PLATE 23

Sarcochilus benguetensis sp. nov.; habit, very much reduced.

PLATE 24

FIG. 1. *Phalaenopsis Lueddemanniana* Reichb. f. var. *purpurea* var. nov.; habit, very much reduced.
2. *Phalaenopsis Lueddemanniana* Reichb. f. var. *purpurea* var. nov.; flower, slightly enlarged.

PLATE 25

Gastrochilus calceolaris D. Don; habit, much reduced.

PLATE 26

Vandopsis Davisii sp. nov.; habit, very much reduced.

PLATE 27

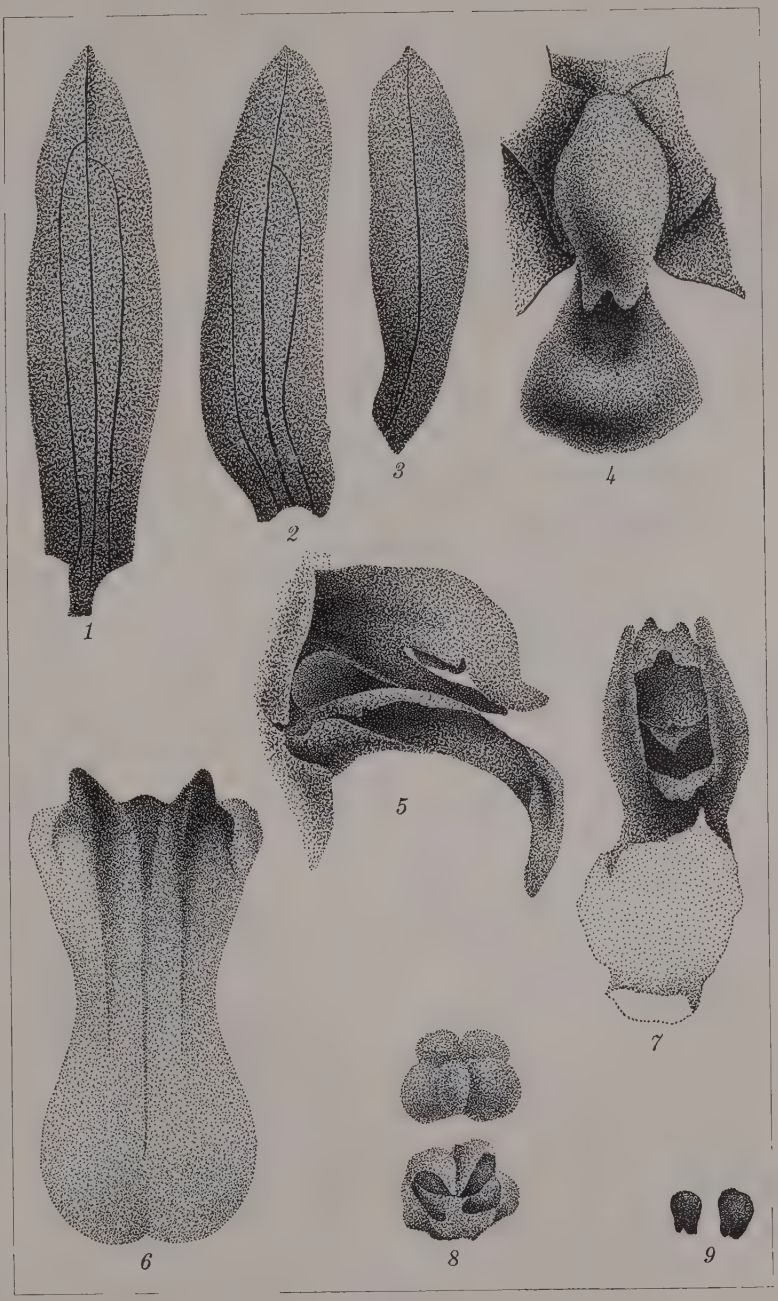
Vandopsis Davisii sp. nov.; flowering raceme, slightly reduced.

PLATE 28

FIG. 1. *Microsaccus Wenzelii* Ames; habit, very slightly enlarged.
2. *Microsaccus Wenzelii* Ames; tops of plants, each with a flower, enlarged about thrice natural size.

PLATE 1.

PLATE 2.



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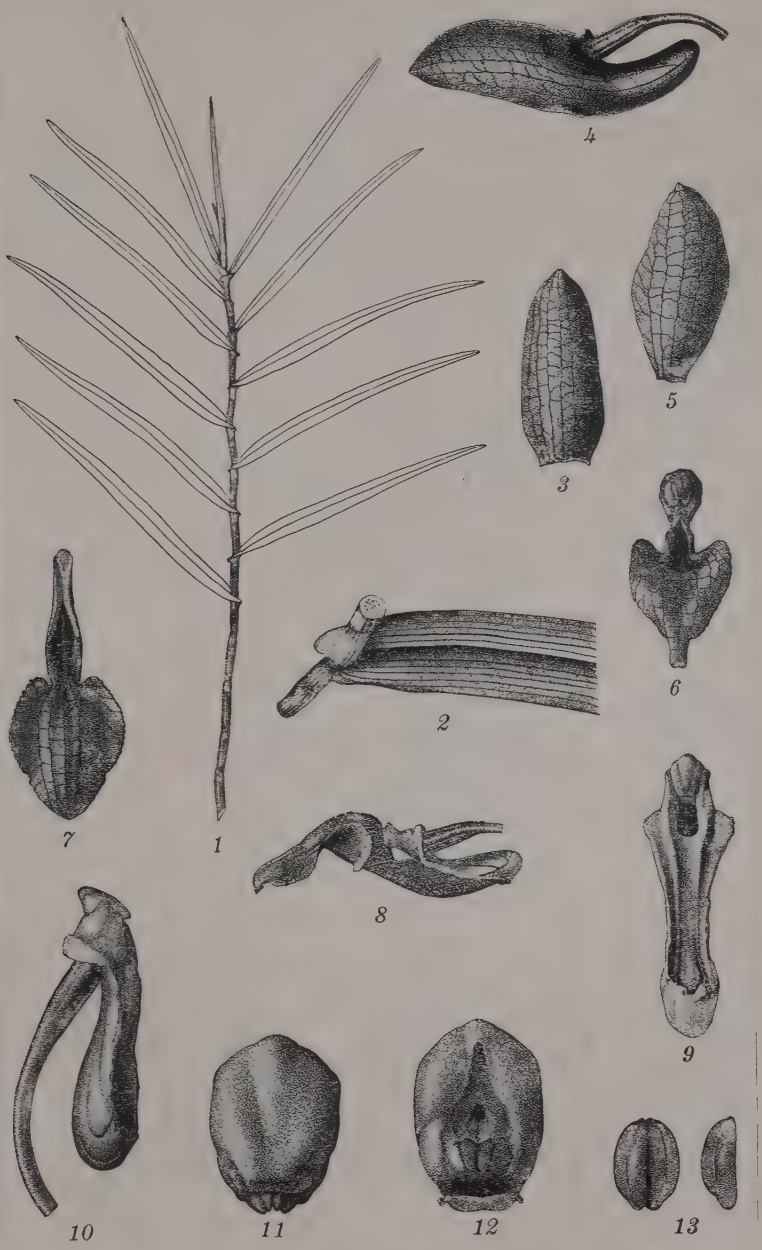

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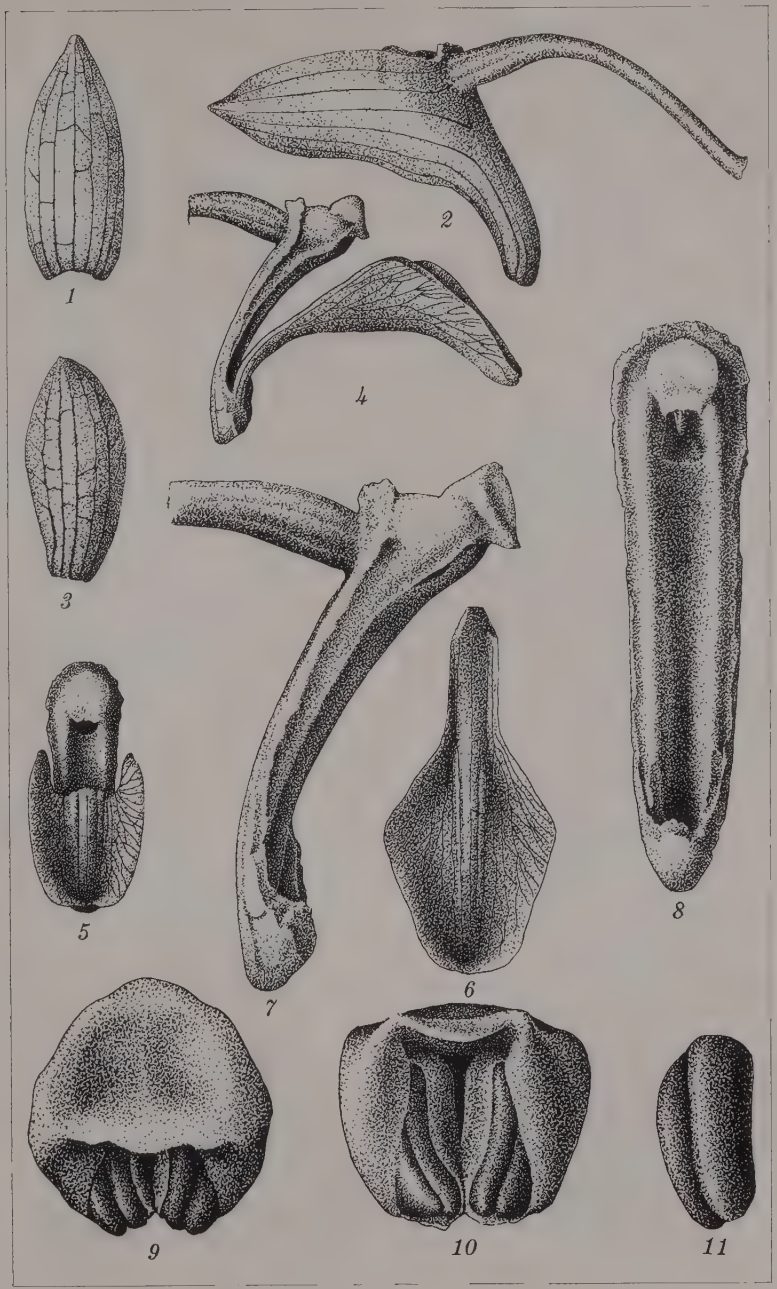

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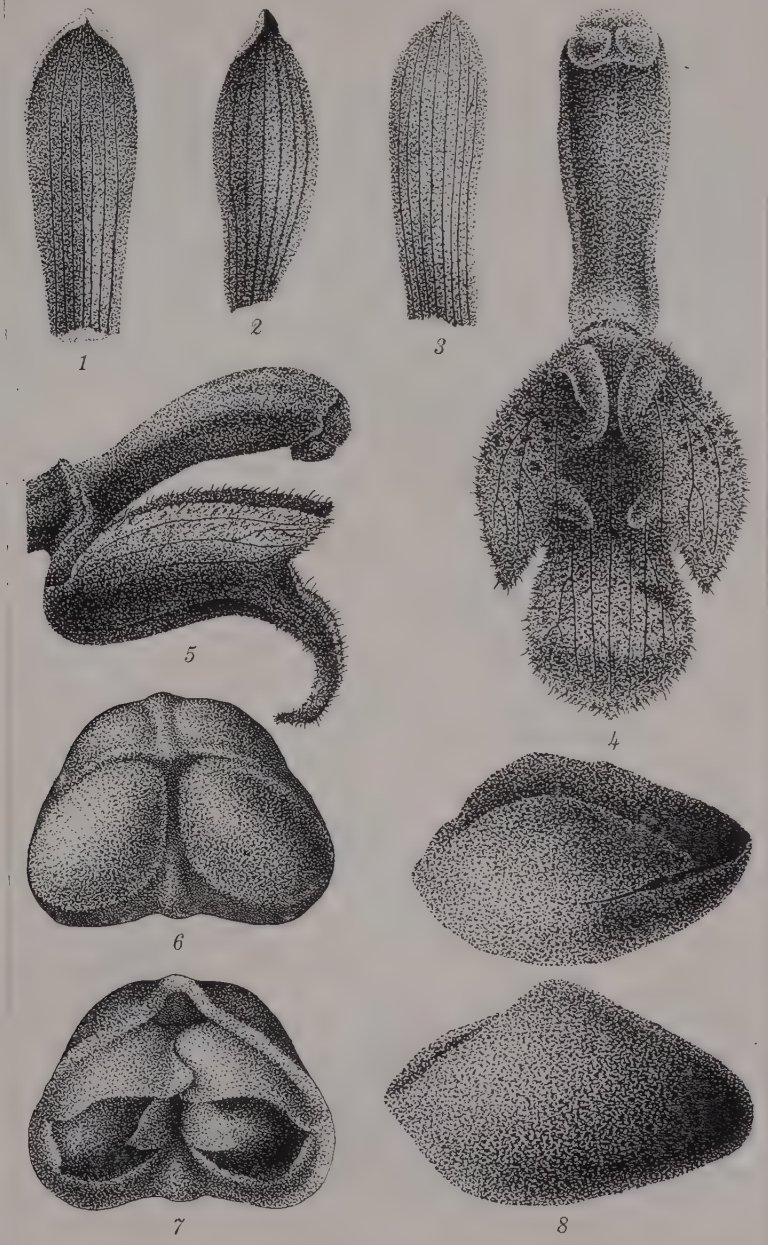

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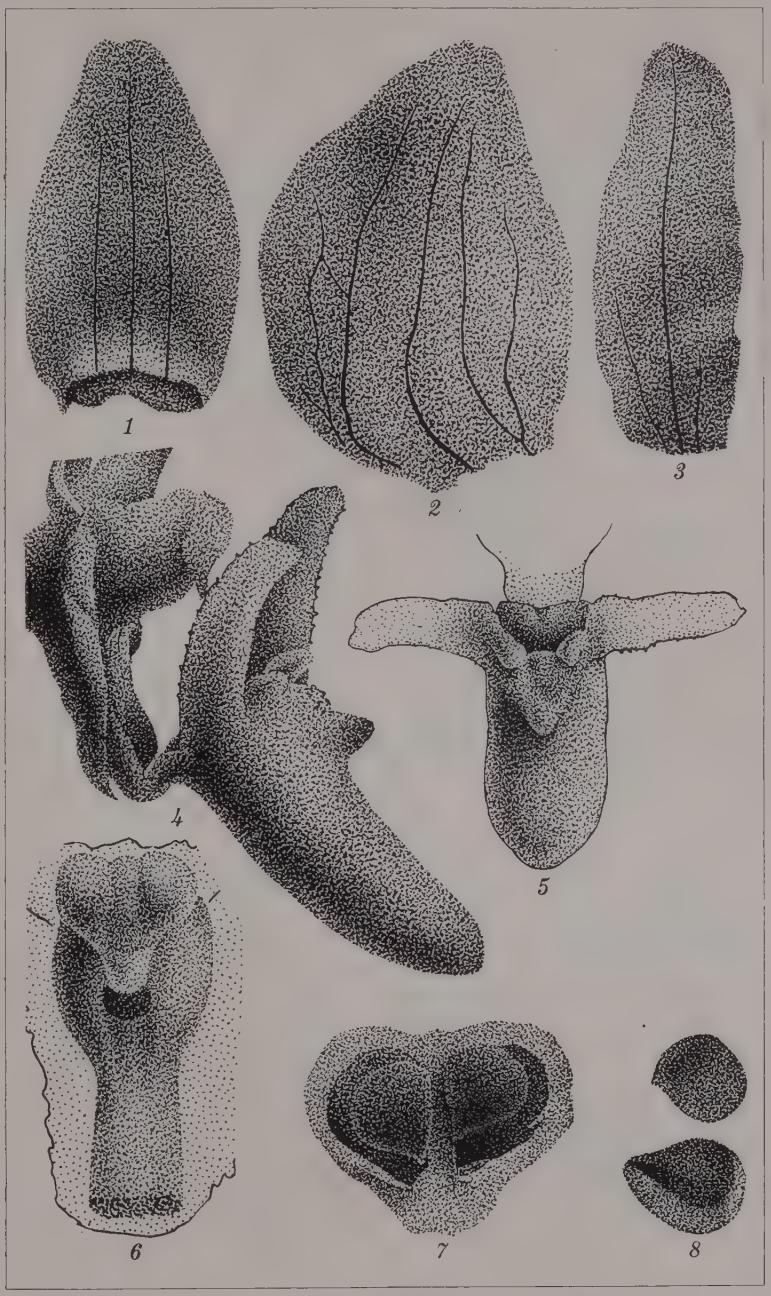

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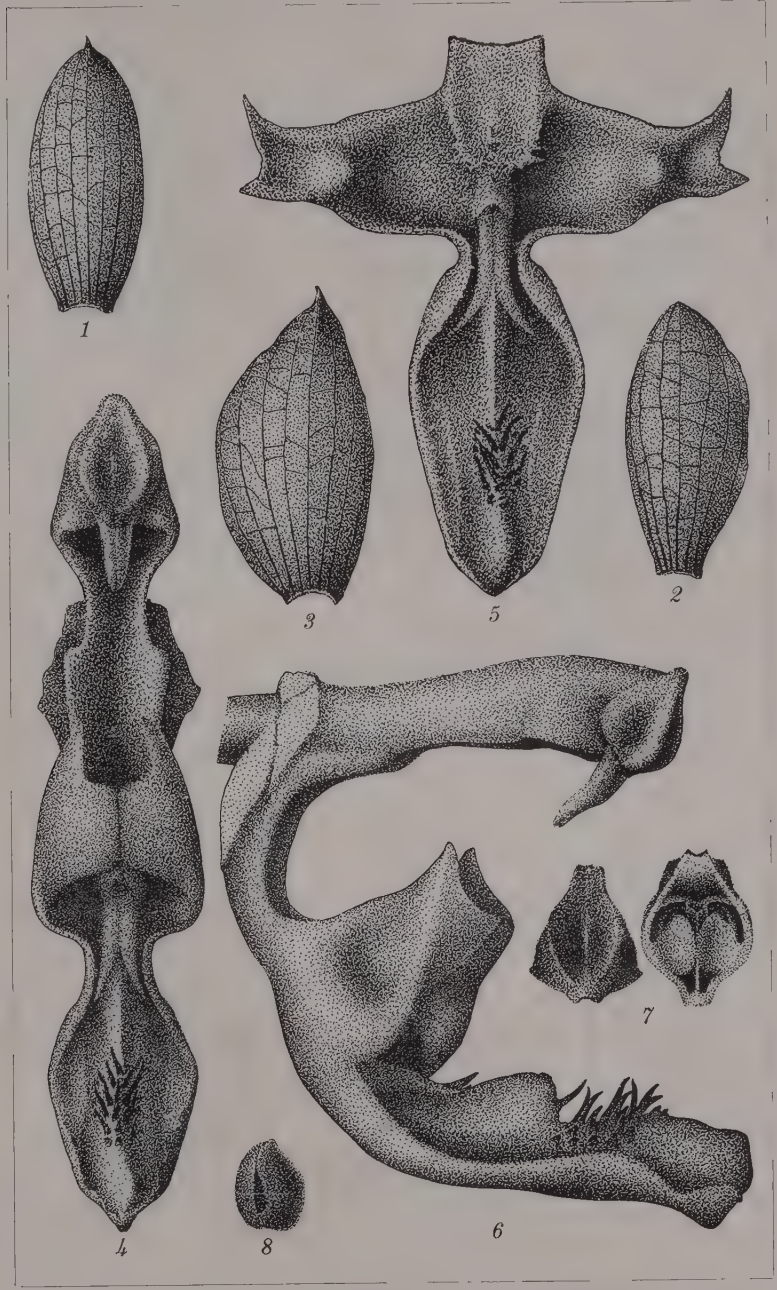

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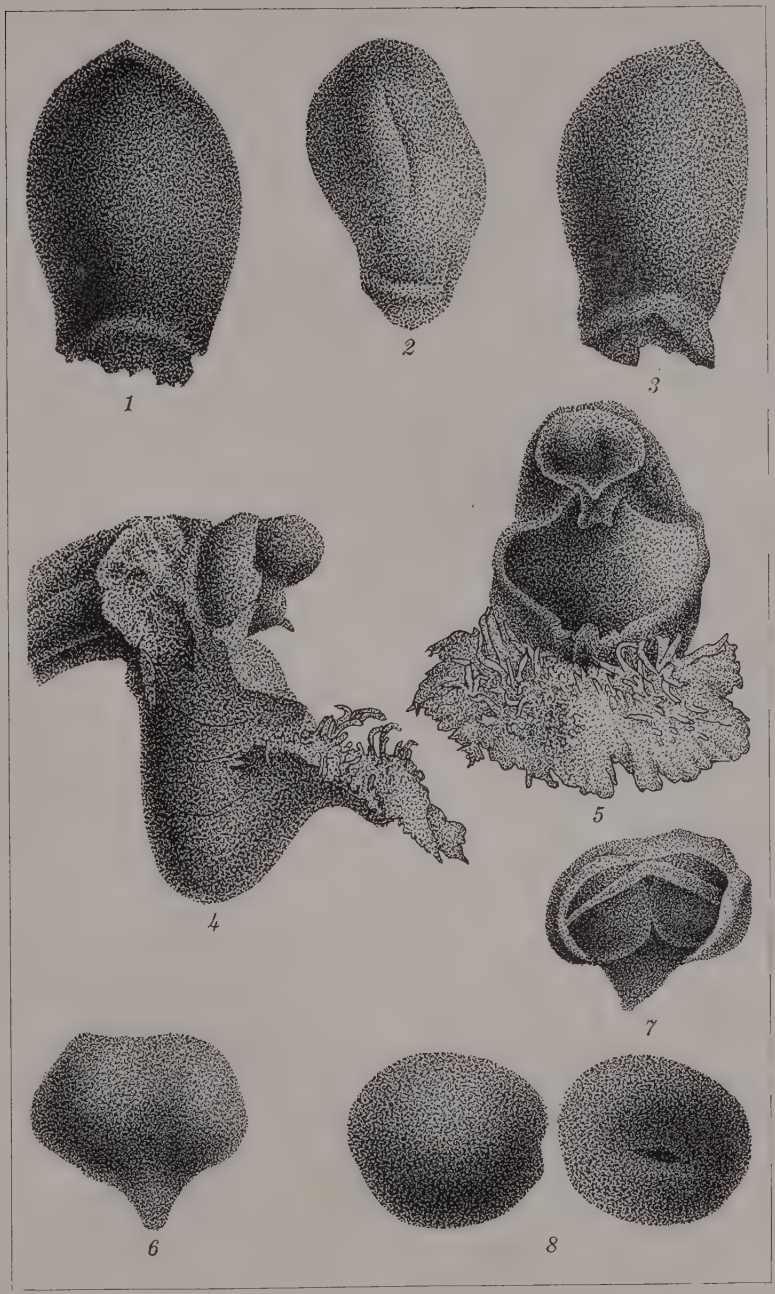

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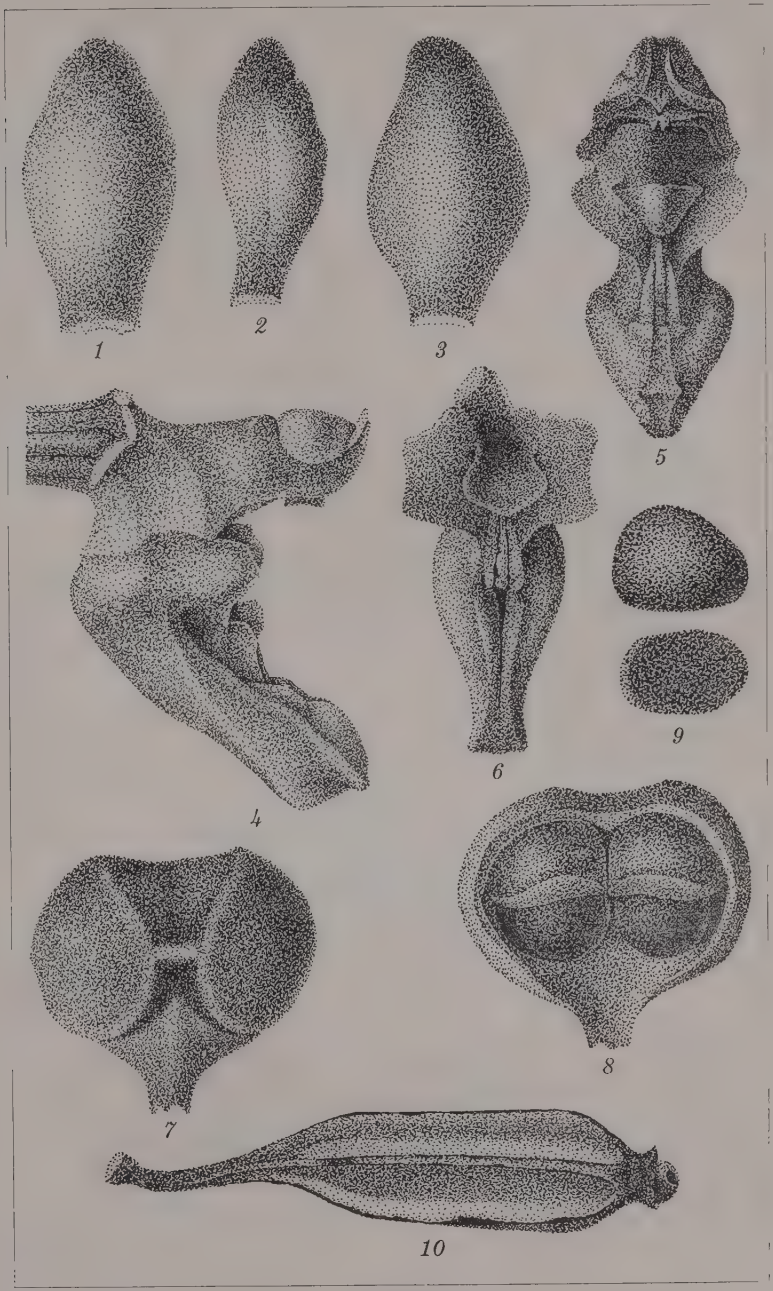

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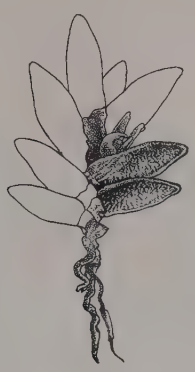
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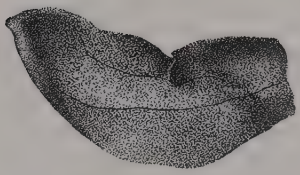
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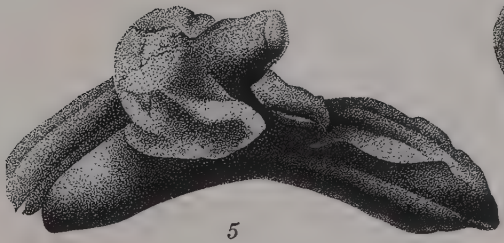
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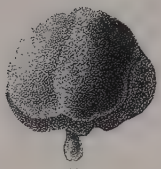
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PLATE 13.

PLATE 14.

PLATE 15.

PLATE 16.

PLATE 17.

PLATE 18.

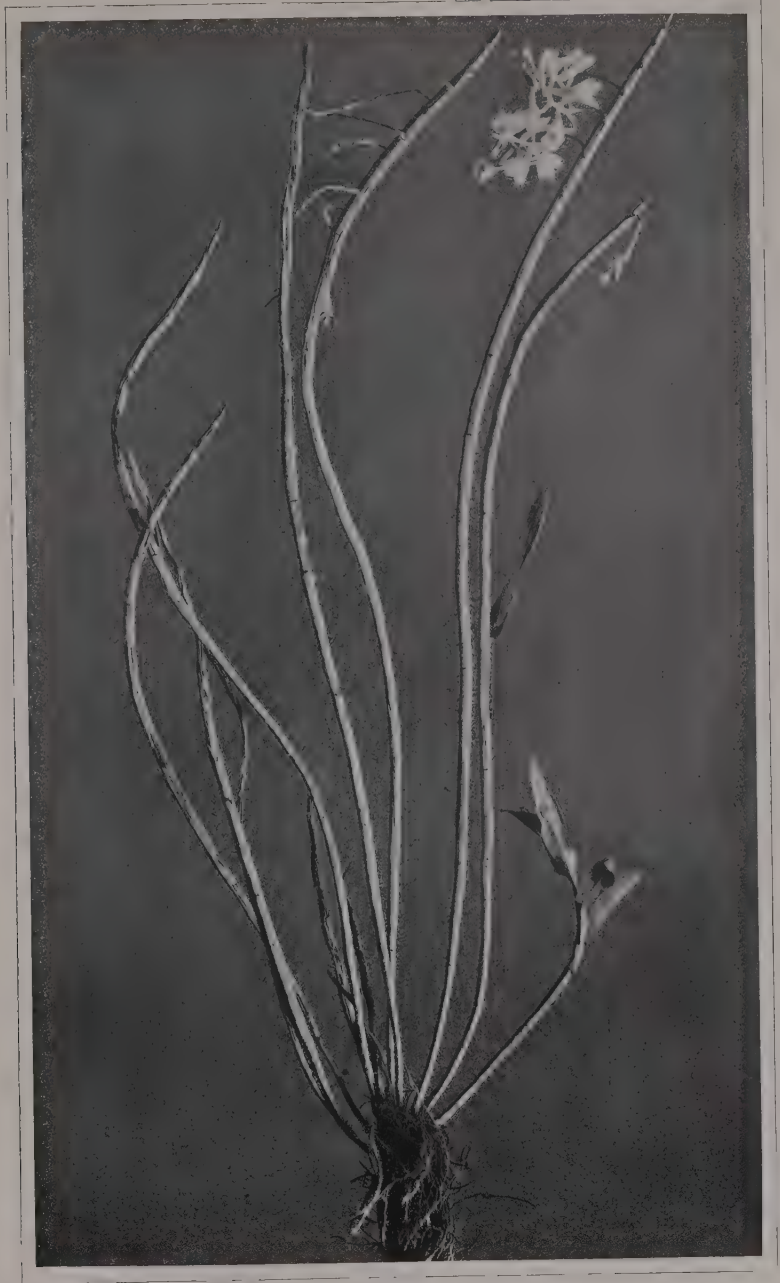


PLATE 19.

PLATE 20.

PLATE 21.

PLATE 22.

PLATE 23.

PLATE 24.

PLATE 25.

PLATE 26.

PLATE 27.

PLATE 28.

ANOTHER COLLECTION OF FRESH-WATER SPONGES FROM THE PHILIPPINE ISLANDS

By N. Gist Gee

Of the Rockefeller Foundation, Peiping, China

NINE TEXT FIGURES

INTRODUCTION

The writer's summary of our knowledge of the fresh-water sponges of the Philippine Islands was published in September, 1931,[1] and listed the four species described up to that time. Through the interest of R. C. McGregor, a collection of sponges made from Pasig River, between Pasig and Laguna de Bay, by Francisco S. Rivera in October, 1930, was sent me for study and a paper describing four additional species, three of them new, was published.[2] Since the preparation of that paper, another species, *Dosilia plumosa,* has been discovered in that collection.

This third report is based upon another interesting collection of sponges, made from the following localities by Messrs. Duyag and Rivera, under the direction of Mr. McGregor:

1. Collections made by Francisco S. Rivera January 6, 1932, and by A. C. Duyag January 12, 1932, at Pinagbuhatan, Rizal, Luzon.

2. A collection made by A. C. Duyag January 11, 1932, at Novaliches, Rizal, Luzon.

3. A collection made by A. C. Duyag January 19, 1932, at San Jose del Monte, Bulacan, Luzon.

4. A collection made by A. C. Duyag January 21, 1932, at Lamesa Dam, Novaliches, Rizal, Luzon.

The collections from Pinagbuhatan contained the following eight sponges:

Spongilla carteri.
Spongilla fragilis var. *decipiens.*
Spongilla proliferens.

[1] Philip. Journ. Sci. 46 (1931) 61–75.
[2] Philip. Journ. Sci. 48 (August, 1932).

Ephydatia crateriformis.
Ephydatia fortis var. *vorstmani.*
Trochospongilla latouchiana.
Trochospongilla phillottiana var. *tunghuensis.*
Dosilia plumosa.

Spongilla fragilis var. *decipiens* was also collected at Novaliches, San Jose del Monte, and Lamesa Dam. *Ephydatia crateriformis* was also found at Lamesa Dam.

It is through the continued interest of Mr. R. C. McGregor that I am able to make these studies, and it is to be hoped that collections covering a wider range of territory and on other islands of the group may be made.

Mr. McGregor has kindly given me the following additional information concerning the several localities from which collections of sponges have so far been made in the Philippine Islands by Bureau of Science collectors under his direction.

1. Pasig River connects a large lake—Laguna de Bay—with Manila Bay and is practically a sewer for Manila as well as several small towns along its banks. High tide backs the water of the Pasig into the lake and both river and lake are full of dirt and trash. The river water is thick with organic matter. The lake is at a low level and the flow of the river is sluggish.

2. Pinagbuhatan is a small town on the banks of Pasig River.

3. Novaliches is a small town about 20 kilometers north of Manila in Rizal Province. Its elevation above sea level is very slight, possibly about 10 meters. The collections of sponges in this place were made from a small, sluggish, muddy stream right at the town.

4. Lamesa Dam, a few kilometers from Novaliches, was built several years ago to impound water for the use of Manila. A large artificial lake has resulted. The dam is only a few kilometers from Novaliches and has only a slight elevation, 10 to 20 meters, above sea level.

5. San Jose del Monte is a small town in Bulacan Province, about 10 kilometers northwest of Novaliches. It is in a country very similar to that around Novaliches. This whole area is volcanic tuff with thin or no covering soil. The elevation is slight, possibly a little higher than Novaliches. The sponges collected in this locality were taken from a small river with clear water.

The table herewith includes a complete list of the fresh-water sponges known from the Philippine Islands to May 6, 1932.

SPONGILLA PROLIFERENS Annandale, 1907. Fig. 1.

Spongilla cinerea WEBER (nec Carter), 1890.
Spongilla lacustris var. *proliferens* ANNANDALE, 1918.

Historical statement.—This species was originally described and figured by Annandale from specimens collected in the In-

Fresh-water sponges known from the Philippine Islands.

No.	Species.	Year described.	Philippine collection.		Type specimen in—
			Locality.	Year.	
1	*Ephydatia fortis* Weltner.	1895	Libmanan River, Luzon.	----------	Berlin Museum.
2	*Spongilla clementis* Annandale.	1909	Lake Lanao, Mindanao.	1907	United States National Museum.
3	*Spongilla philippinensis* Annandale.	1909	-----do----------	1907 and 1908.	Do.
4	*Spongilla microsclerifera* Annandale.	1909	Taal Lake, Taal Island, Luzon.	1907	Do.
5	*Spongilla tinei* Gee-----	1932	Pasig River, Pasig---	1930	Gee's collection.
6	*Spongilla luzonensis* Gee.	1932	-----do----------	1930	Do.
7	*Trochospongilla latouchiana* var. *pasigensis* Gee.	1931	-----do----------	1930	Do.
8	*Ephydatia fluviatilis* var. *meyeni* (Carter).	1849	-----do----------	1930	British Museum.
9	*Spongilla carteri* Carter.	1859	Pinagbuhatan, Rizal, Luzon.	1932	Do.
10	*Spongilla fragilis* var. *decipiens* Weber.	1890	Pinagbuhatan, Lamesa Dam, Novaliches, and San Jose del Monte, Luzon.	1932	Amsterdam Museum
11	*Spongilla proliferens* Annandale.	1907	Pinagbuhatan, Rizal, Luzon.	1932	Indian Museum.
12	*Ephydatia crateriformis* Potts.	1882	Pinagbuhatan and Lamesa Dam.	1932	United States National Museum. Cotype only.
13	*Ephydatia fortis* var. *vorstmani* Gee.	1930	Pinagbuhatan, Rizal, Luzon.	1932	Buitenzorg Museum.
14	*Trochospongilla latouchiana* Annandale.	1907	-----do----------	1932	Indian Museum.
15	*Trochospongilla phillottiana* var. *tunghuensis* Gee.	1926	-----do----------	1932	Gee's collection.
16	*Dosilia plumosa* Carter.	1849	Pasig River, Pasig--- Pinagbuhatan-------	1930 1932	British Museum.

dian Museum tank in Calcutta, India.[3] At that time Annandale considered this sponge as a distinct species, and in 1911 he again described it as a separate species, but in 1918[4] he listed it as a variety of that cosmopolitan species *Spongilla lacustris*. The original illustrations accompanying his description seem to me to confirm this position, but specimens in my

[3] Journ. and Proc. Asiatic Soc. Bengal 3 (1907) 15–17.
[4] Mem. Asiatic Soc. Bengal 6 (1918) 210.

collection from the Indian Museum indicated as this species raise serious doubts in one's mind as to the accuracy of these original drawings. The descriptions are not given in enough detail to enable one to come to a final decision in the matter. Schröder maintains that the forked or branched spines of the gemmule spicule is the chief distinguishing characteristic of this species; this position, however, does not seem to me altogether satisfactory though it was accepted tentatively in my description of this species from Java.[5] A sponge similar to that one has been found in the Philippine collections made from Pinagbuhatan, January 6, 1932. This sponge is quite different from *Spongilla lacustris* and is undoubtedly entitled to specific distinction.

Habitat.—In India, this species was found in permanent ponds; in Malaysia, Weber found it in small streams. There are only a few small specimens in the materials sent from Pinagbuhatan and they were all growing on small dead sticks,

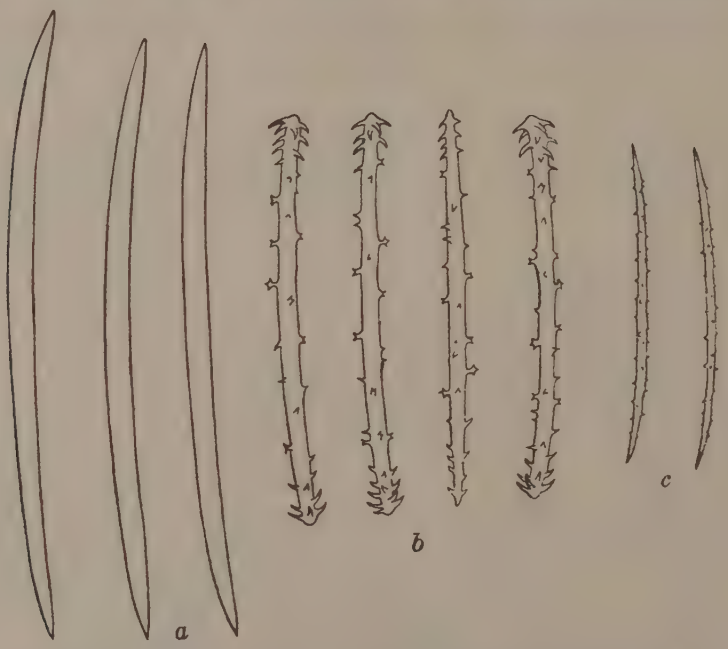


FIG. 1. *Spongilla proliferens*, spicules; *a*, smooth skeleton spicules; *b*, gemmule spicules, showing heavy, recurved spines near the ends and the divided or multiple-pointed spines in the middle area of the spicules; *c*, the small sharp-pointed flesh spicules.

[5] Treubia 12 (1930) 77–81.

entirely covering their supports with a very thin layer of sponge; the thickness of the sponge does not in any case exceed 3 or 4 millimeters and the longest specimen covers the support for a length of 7 centimeters.

General characteristics.—None of these Philippine sponges representing this species have any outstanding body form by which they may be identified; they are all small and their shape is entirely determined by the supports upon which they were growing. The surfaces of the sponges are irregular, but have been rather badly broken in transmission; they do not appear to have borne lobes or branches; neither do their surfaces closely resemble the larger Java sponges of this species. The oscula are few and inconspicuous. The entire sponge is easily broken. In one or two of the specimens gemmules are lacking but in others they are abundant. These sponges have evidently been growing close to the colonies of *Spongilla carteri* and there is more or less mixing of the gemmules of that common species with those of the rarer *Spongilla proliferens.*

Color.—All of the specimens of this sponge are green in color, due to the presence of a symbiotic algal form growing with them.

Structure.—The skeletal structure is made up of irregular meshes with no conspicuous long spicula fibers. The fibers are all thin and composed of a small number of spicules; this causes the meshes to be rather loose and fragile, and they crumble very easily. The amount of spongin is not large, though often thin films of it may spread over the space between the sides of the meshes.

Skeleton spicules.—The skeleton spicules are spindle shaped, and in most cases are tapering gradually from the center to very sharp points at their ends. They are smooth, slightly curved, rarely straight, rather long and thin. They measure from 331 to 416 microns long and average from 12 to 14 microns in diameter; some of them are slightly smaller but a few may measure as much as 18 microns in thickness.

Flesh spicules.—The flesh spicules are very rare in these specimens. They are thicker at the center and become smaller toward their ends; the ends usually terminate in sharp points. They are gently curved and bear very minute, sharp, conical spines scattered sparsely all over their surface right up to near their ends. In their thickest part they are less than half as thick as the gemmule spicules. They vary in length

from around 78 to 90 microns and from 1.5 to 3 microns in thickness in their centers.

Gemmules.—The gemmules are spherical, abundant in some of the specimens, and are light brown or dirty white in color, thus contrasting sharply with the general green color of the sponge. They occur singly and are scattered indiscriminately throughout the sponge body. They have a simple pore tube which at times projects somewhat beyond the surface of the gemmule coat and is surrounded by gemmule spicules bound together by the granular material with which the prevailingly perpendicularly arranged gemmule spicules are held together. Many of the gemmules do not seem to have projecting pore tubes or they are broken off in the teasing of them out of the sponge. The spicules on the outer portion of the gemmule are often irregularly arranged and have no definite system at all; the inner ones are quite regular and are perpendicular to the surface of the gemmule. The Philippine representatives of this species have gemmules measuring from 493 to 562 microns in diameter.

Gemmule spicules.—The gemmule spicules are curved, rarely straight, cylindrical ones of an almost uniform diameter terminating either in rounded ends with a number of sharp, recurved spines around them, or in a large sharp spine around the base of which are arranged similar recurved spines; even the terminal spine itself is often curved. The sharp-pointed, recurved spines extend a short distance from each end toward the center of the spicule but are then replaced by divided or compound spines; they may form simple or modified Y-shaped spines, or they may frequently form compound ones such as this; these spines may have a great variety of forms, from simple conical ones to several branched ones. While the spines are all over the spicule, yet they are often more numerous nearer the ends and are fewer and more scattered in the central region. The spicules vary in length from 88 to 96 microns and are from 3 to 5 or 6 microns thick.

Type.—Annandale's type of this species is preserved in the collections of the Indian Museum, Calcutta, India.

Distribution.—*Spongilla proliferens* is now known from all over eastern India, from Cochin on the western coast of India, from Ceylon, from several localities in Burma, from Java, from Flores, from Celebes, and from Lombok. This record from the Philippine Islands extends its range considerably. There are

two forms of a very similar sponge found in several places in eastern China along the coastal provinces and also in Japan; Annandale called these *Spongilla micron* and *S. semispongilla*. Doubt still attaches to the correctness of these identifications.

Remarks.—There seems to be a good deal of confusion and uncertainty with reference to this sponge. Annandale (1911) states that "*Spongilla proliferens* can be distinguished from all forms of *Spongilla lacustris* and *Spongilla alba* by the fact that its gemmules possess a foraminal tubule; from *Spongilla cinerea*, it can be distinguished by its color and its smooth skeleton spicules; from *Spongilla travancorica* by its free gemmules."

In 1909 Annandale described *Spongilla semispongilla* from Japan and he distinguished this from *Spongilla lacustris* by the "peculiarities of its gemmule spicules and by the complete absence of microscleres" (flesh spicules). In 1916, Annandale described *Spongilla micron* from China and he distinguished this from *S. alba* by its invariably smaller size, by the subrotulate form of its gemmule spicules, and by the absence of true flesh spicules. He distinguished *S. micron* from *S. semispongilla* by the entire absence of chlorophyll bodies and the much more slender skeleton spicules of the former.

It seems to the writer that there is little danger of confusing *Spongilla proliferens* with *S. lacustris*, *S. alba*, or *S. travancorica* (now a synonym of *S. alba*), but there is a great deal of similarity between *S. proliferens*, *S. micron*, and *S. semispongilla*. If we accept the gemmule spicule as the final criterion, then these three sponges probably belong to the same species and the last two would become synonyms, or varieties at most, of *S. proliferens*.

The questions of the presence of flesh spicules and of the projecting pore tube of the gemmule are open to doubt. It is very easy to confuse the very young gemmule spicules with flesh spicules when the sponges are found in the actively growing stage, especially when the flesh spicules are very rare, as they are in *Spongilla proliferens*. I find in my cotypes of both *S. micron* and *S. semispongilla* very young gemmule spicules which might readily be taken for flesh spicules.

When gemmules are carefully teased out with their adherent spicules from the sponge body, often there are small bunches of spicules and granular material built up around the pore tube, but even in *S. proliferens* many of the gemmules are without the projecting tubes.

Further study must be made of this subject before one is prepared to accept unreservedly the idea that these three sponges, *S. proliferens*, *S. micron*, and *S. semispongilla*, are identical; we readily accept the idea that they are closely related.

SPONGILLA CARTERI Carter, 1859 (Bowerbank in literature). Fig. 2.

Spongilla friabilis CARTER, 1849 (nec Lamarck).

Historical statement.—Since there seems to be an element of doubt about this sponge being the one described by Carter,[6] it would seem the wiser course to accept his description of this sponge in this same publication,[7] as the type description. Carter sent his specimen to Bowerbank, who after examination gave it the name *Spongilla carteri*. Bowerbank's description [8] did not appear in print, however, until several years after Carter's article mentioned above had been printed in 1859. This makes it necessary to credit the species to Carter (because he made public the first description of it) though the species was named for him by Bowerbank. Since Bowerbank's description this species has been described and illustrated a number of times. The writer has recently published a full illustrated description.[9]

Habitat.—In other parts of the world this sponge has been found growing both in running and in still waters. The China specimens have come almost exclusively from still water, in fact largely from the shallow ponds among the paddy fields. Some of the specimens were growing upon a basal support, but most of them are around plant supports or are thoroughly impregnated with clay. Several of the Java specimens are very clean and free from sediment. The Philippine Islands sponges of this species were all collected at Pinagbuhatan and are, as a rule, much cleaner and much freer from sediment than are the China ones; some of the Philippine Islands specimens, however, are also full of sediment.

General characteristics.—The collection contains many of these sponges and it is judged that they were very abundant. They vary in size from more or less elongated or oval colonies from 3 or 4 centimeters in length and 2 or 3 centimeters in diameter to very much larger colonies, measuring as much as 18 centi-

[6] Ann. & Mag. Nat. Hist. II 4 (1849) 83.
[7] Ann. & Mag. Nat. Hist. III 3 (1859) 334.
[8] Proc. Zool. Soc. London (1863) 469.
[9] Treubia 12 (1930) 70–74.

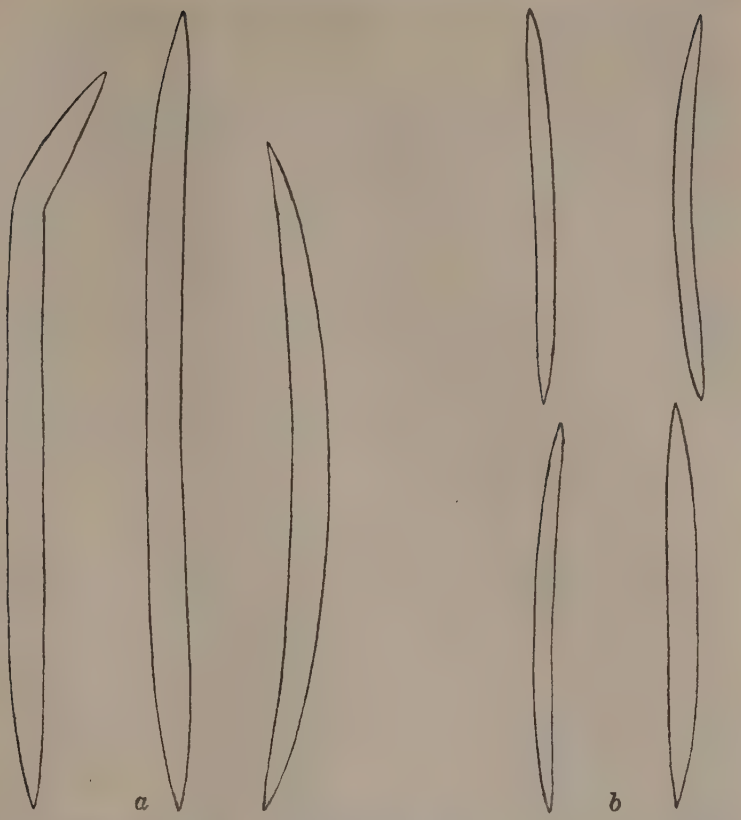


FIG 2. *Spongilla carteri*, spicules; *a*, smooth skeleton spicules; *b*, very similar, but smaller, gemmule spicules.

meters long by 8 or 10 centimeters in diameter. The surfaces are rarely smooth, generally they are very irregular with numerous elevations and depressions, sometimes with short, rounded knobs or lobes projecting from the surface. All of the specimens are full of gemmules massed in the meshes throughout the parenchyma. In nearly every sponge there is at least one large osculum, sometimes more than one. In some of my specimens the oscula have diameters as large as 1 centimeter or over.

Color.—Nearly all of the sponges are a dirty light brown on the inside; the cleaner the sponge the lighter the color will be. In some cases the sponges are covered with a green algal growth, while other sponges are almost black.

Structure.—Definite vertical fibers begin from the support on which the sponge is growing and extend all the way to its outer surface. The fibers are composed of several of the heavy spicules and are bound together by thinner and shorter irregular transverse fibers. The amount of spongin is not large and the sponges crumble very readily from rough handling. The structure of the body is open and when dry the gemmules in large numbers are easily shaken out when the sponges are being examined.

Skeleton spicules.—The skeleton spicules are rather heavy, spindle-shaped, thicker in the center and gradually taper to pointed ends. They are smooth and generally a little curved, though straight spicules are not entirely lacking. Considerable variations in the spicule dimensions occur; they vary in length from 289 to 365 microns and in diameter from 14 to 24 microns.

Flesh spicules.—*Spongilla carteri* does not have any flesh spicules.

Gemmules.—The gemmules occur singly and are very abundant, being scattered without any definite arrangement throughout the entire sponge body from the support on which it grows right on up to near the outer surface. Each spherical gemmule is surrounded by a thick layer of regularly arranged polygonal air cells, within and on the surface of which the gemmule spicules are placed. When observed from the side, the air-cell walls seem to form a series of nearly parallel lines perpendicular to the surface of the gemmules and these lines are connected by short transverse lines, or cell walls, at fairly regular intervals. The pore tube is simple and is sometimes slightly constricted as it emerges from the gemmule, but it expands and opens into a funnel-like depression on the outer surface of the gemmule air-cell coat. The gemmules are slightly lighter in color than the sponge parenchyma and are quite large, measuring from 450 to 600 microns in diameter.

Gemmule spicules.—The gemmule spicules are very similar to those of the skeleton, they are smaller, more curved, smooth, and sharp pointed. Often one or both ends may be decidedly curved inward, forming a bowlike structure; sometimes abnormally shaped spicules are fairly numerous in the slides. They commonly range between 168 and 206 microns in length and between 5 and 9 microns in thickness.

Type.—The type, the specimen sent by Carter to Bowerbank, is preserved in the collections of the British Museum in London, England.

Distribution.—A form of this sponge, which has been designated as variety *balatonensis,* has been found as far west as Lake Balaton, Hungary. *Spongilla carteri,* or its related forms, has also been found in the following localities from that point eastward: Southern Russia, Persia, Turkestan, India, Ceylon, Burma, Siam, Sumatra, Java, Madura, Flores, and southeastern China, and now it is recorded from Pinagbuhatan, Luzon, Philippine Islands. A specimen from Lake Victoria Nyanza has also been referred to this species, and another specimen has been reported from Mauritius Island, east of Madagascar.

Remarks.—The Philippine specimens of *Spongilla carteri* resemble very closely the specimens I have of this species from China and from Siam. The Java sponges were, on the whole, cleaner and freer from the discoloring sediments and were therefore of a more normal sponge color, that is light yellowish brown. The Java specimens were also more delicate and more fragile and had been, in most cases, badly crushed in transportation. The Philippine specimens were more compact and of a stronger structure and have arrived in better condition.

SPONGILLA FRAGILIS var. DECIPIENS Weber, 1890.[10] Fig. 3.

Spongilla decipiens WEBER, 1890.

Historical statement.—This sponge was first described by Max Weber,[11] of Amsterdam, Holland. It is closely related to the cosmopolitan species, *Spongilla fragilis,* and there was some doubt in Annandale's mind as to whether or not it is entitled to varietal distinction; in 1909, after examining a large series of materials, he placed this sponge as a synonym of *Spongilla fragilis,*[12] stating that the large series of specimens now in the Indian Museum seems to afford a complete transition between *Spongilla fragilis* and Weber's *Spongilla decipiens,* which must, therefore, be regarded as a synonym. In 1911, Annandale[13]

[10] Gee, Treubia 12 (1930) 74–77.

[11] Zoologische Ergebnisse einer reise in Niederlandisch Ost-Indien (1890) 40–42.

[12] Proc. U. S. Nat. Mus. 37 (1909) 402.

[13] Fauna British India, Freshwater Sponges, Hydroids, & Polyzoa (1911) 97.

calls this sponge a "subspecies" of *Spongilla fragilis*, but in 1918,[14] he records it as a "variety" of that species. It is at least entitled, the writer thinks, to varietal separation.

Habitat.—Weber's specimens were collected from Lapadi River, southern Celebes, and were growing on stones, leaves, and branches of trees immersed in strong currents of water. The Philippine Islands specimens were collected in large numbers, indicating their abundance, and from all four of the localities (Pinagbuhatan, Novaliches, Lamesa Dam, and San Jose del Monte) where collections were made; this being the only sponge found in all of the places visited by the collectors in making the present collection. In every case, the sponges were growing on the small submerged stems or roots of plants.

General characteristics.—The specimens of this sponge present three fairly distinct and different methods of growth in the materials which I have in hand, in fact, they were so unlike in appearance that upon a casual examination of the specimens as they were being unpacked, I thought they represented three different sponges. One specimen representing each type of growth will be briefly described.

Growth type 1; specimen 54959.—This specimen is typical of one form. It consists of two sticks, one 15 centimeters long and about 8 millimeters in diameter and a smaller one 10 centimeters long and about 6 millimeters in diameter, both being entirely covered and bound together by a thin film of sponge not more than 3 or 4 millimeters thick in any part and only about 1 to 2 millimeters thick over most of the area. The surface is comparatively even and smooth but is clearly marked in parts by the canals just on the surface seeming to radiate from centers. The color of this specimen is blackish, probably due to the nature of the water in which it was growing. The gemmule peculiarities are described below.

Growth type 2; specimen 54967.—This specimen consists of a small twig, probably a rootlet, the entire length being not more than 10 centimeters. (The greater part of the very large number of specimens representing this type of growth are much larger than the one described; they frequently measure two or three times as long as this one and consist of many branches which bear patches of sponges varying in size and extent. Most of these do not bear gemmules.) In parts of the specimen the sponge joins two or more of the twigs together forming a thin

[14] Mem. Asiatic Soc. Bengal 6 (1918) 212.

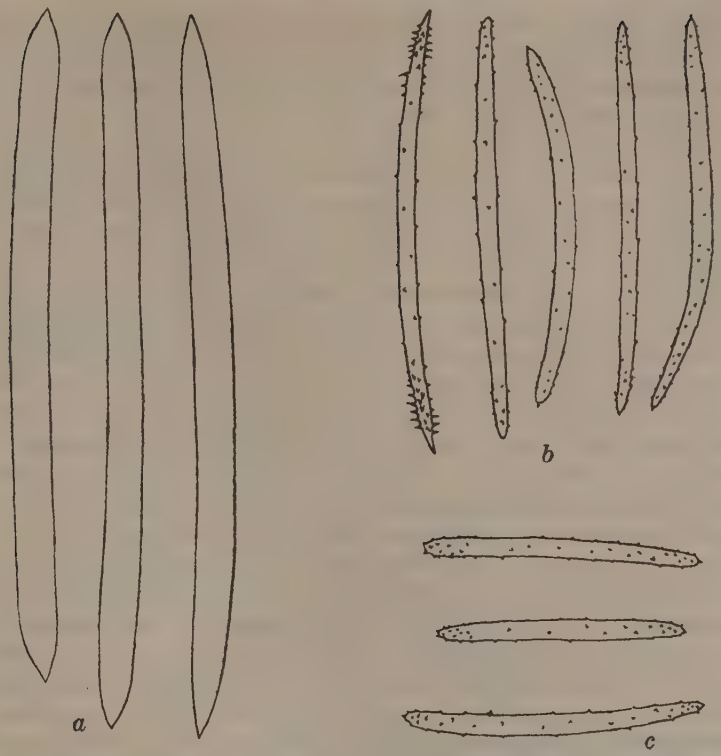


FIG. 3. *Spongilla fragilis* var. *decipiens*, spicules; *a*, smooth skeleton spicules abruptly sharpened; *b*, longer gemmule spicules, showing various shapes and the variety in the size and arrangement of the spines; *c*, shorter gemmule spicules.

layer of sponge across the space between the supports. A portion of the sponge forms a continuous covering of the support, in other parts there are only small nodules which grew around the support; these are thickest in the center and become thinner toward their outer edges. The general form is that of the support, and the smooth, surfaced cushion of sponge is not often more than a few millimeters in thickness. The color of this group of sponges is generally light brown or tan.

Growth type 3; specimen 54941.—This sponge has quite a different habit of growth from the other two and its general appearance would lead one to think that it was not even closely related to them. It also grows on plant supports, altogether covering them but forming larger and thicker masses of sponge. The sponge frequently fuses all the growths around several twigs together into one mass; one specimen is over 15 centimeters

long and in certain parts the fused masses of sponge are 4 or 5 centimeters in thickness. The surfaces of this form are also quite irregular, bearing rounded ridges or shallow furrows with rounded bottoms. The color is from a dark brown to black.

Color.—As has been stated above, the color of these sponges varies from a light brown or tan to black; all the intermediate shades may be found by searching through a large series of specimens.

Structure.—The sponge never grows to be very thick in our specimens; the thickest ones are the result of the fusing together of the films around several small twigs. The vertical fibers are weak but distinct and clearly visible; they are bound together by short transversely placed single spicules or small groups which are hardly regular enough to be called fibers. The spongin is small in amount and the fibers are never heavy. The general structure, both in cross section and on the surface, has the appearance of being made up of an uneven meshwork.

Skeleton spicules.—The skeleton spicules are smooth, spindle-shaped, and pointed at both ends. In most cases they are of nearly uniform diameter, tapering only slightly from the center, and are abruptly sharpened into blunted points at the ends. Only a few are straight, most of them being somewhat curved. Now and then much finer spicules are found which taper very gradually into very fine points at their ends. The extremes vary from about 200 to 332 microns in length and from 12 to 22 microns in thickness. The average ones, however, measure from about 230 to 250 microns in length and from 13 to 17 microns in diameter.

Flesh spicules.—There are no flesh spicules in this species.

Gemmules.—The arrangement of the gemmules is different in the three types of growth described above.

Growth type 1.—In this type the gemmules are arranged in a layer at the base of the sponge and upon the support. The layer is generally quite regular and for the most part only one gemmule thick with their pore tubes all pointing upward away from the support. As a rule, these patches are small but one specimen (No. 54945), from which the covering layer of sponge has been removed, is a stick about 1.5 millimeters in diameter and is entirely covered by a solid layer of gemmules for a length of 5 centimeters. In places the layer becomes two gemmules thick and there are several small spots where the layer is even

three gemmules thick. This is the largest number of gemmules I have found together in any of the specimens of this species; usually the patches are very much smaller than the one just described. The straight chitinous pore tubes are darker in color than the gemmule coat and they sometimes project beyond the surface of the coat.

Growth type 2.—The patches in this form are generally very small and consist of only a comparatively small number of gemmules forming a single layer at the base of the sponge. One flat patch rather larger than the usual is somewhat elliptical in shape and measures 6 by 3 millimeters. I have not found these in double layers.

Growth type 3.—In the sponges of this type the gemmules are also in a single layer upon the support and some few of them are scattered in the meshes of the sponge. The gemmules in the body of the sponge are usually bound together in small groups and suggest the arrangement typical of *Spongilla fragilis.*

The gemmules are found to be very variable in size, ranging from about 212 to as much as around 500 microns in diameter. They are inclosed in a layer of polygonal air cells. I have found the gemmules in the layer on the support all bound together and the entire layer is of a uniform color. While the upper portion of each gemmule with its pore tube pointing upward rises above this layer yet the lower portion is covered over by this air-cell layer into which are woven and bound tightly together numbers of both skeleton and gemmule spicules. The number of gemmule spicules around the gemmule seems to be very variable; they are placed, as a rule, tangentially and around the base of the pore tubes, their ends often overlap forming a chimneylike structure. I find, contrary to Weber's statement, that the pore tubes do sometimes project a little above the gemmule coat. The lower half of the gemmule seems to have fewer gemmule spicules than the upper portion and frequently even these are left attached to the support as the gemmules are teased away and one might get the idea that the lower half of the gemmule is altogether bare. I have found that the layer of hexagonal, or polygonal, air cells connecting the gemmules all together is present, though I have not found it as clearly defined as Weber has described and illustrated it in his original descriptions.

Gemmule spicules.—The gemmule spicules are usually thicker in the center and gradually taper somewhat to either rounded or

sharpened tips. They are generally curved, sometimes irregularly angular, though straight ones, often shorter than the others, are at times found. The spicules bear sharp spines irregularly distributed all over their surfaces; the spines as a rule are larger and more numerous near the ends of the spicules and, in a few cases, one or two large spines have been observed near the end which are curved inward toward the center of the spicule.

These spicules vary from 80 or 90 to 192 microns in length and from 3 or 4 to 11 microns in diameter, but the average ones are from 120 to 150 microns long and from 7 to 9 microns in diameter.

Type.—The type of this sponge is preserved in the Amsterdam Museum, Holland.

Distribution.—The type specimen from which this sponge was originally described by Weber was collected from the Lapadi River at Sare-minja near Pare Pare, on the western coast of South Celebes. Annandale recorded it from the Indian Museum tank, Calcutta, India, on Weltner's authority, but he doubted the identification and believed the specimen in question to be *Spongilla fragilis* var. *calcuttana*. The finding of this sponge in the Philippine Islands extends its range considerably. It was collected in each of the four localities from which specimens in this collection were sent me—Pinagbuhatan, Novaliches, Lamesa Dam, and San Jose del Monte—and, judging from the number of specimens sent, it must be a very common sponge.

Remarks.—Annandale (1911) states that "this (?) local race is distinguished by the fact that the foraminal tubules are invariably short and straight and thickened at the tips, and that gemmule spicules do not occur on the external surface of the cellular coat of the gemmules." In the various specimens examined a few projecting foraminal tubules are found, and most of the gemmules have gemmule spicules on the outer coat of the gemmule. I find that the arrangement of the gemmules, their method of being bound together, and the differences in the spicules of this sponge from those of the type form of the species more constant characters for determining the variety.

EPHYDATIA CRATERIFORMIS (Potts), 1882. Fig. 4.

Meyenia crateriformis POTTS, 1882.
Spongilla crateriformis ANNANDALE, 1911.

Historical statement.—This species was described from specimens collected in Brandywine Creek, near Chadd's Ford in

September, 1881, by E. Potts.[15] This species has been found in other parts of the world, and descriptions of it have appeared a number of times in different journals under both generic names, *Ephydatia* and *Spongilla*. The rotule of the birotulate spicule is distinct, and the writer holds that it properly belongs to the genus *Ephydatia*. This species has now been found in Pinagbuhatan and Lamesa Dam, Novaliches, Philippine Islands. The writer has published a very full discussion of this species.[16]

Habitat.—It seems that this sponge rather prefers still waters and that most of the specimens have been found in ponds, lakes, canals, or other quiet waters. There are many specimens of *Ephydatia crateriformis* in the Philippine Islands collection; and they were without a single exception all growing around or attached to some support, usually small dead twigs many of which must have dropped into the water from overhanging trees. Some of the specimens entirely cover small leaves.

General characteristics.—The very thin cushions of sponges covering the small stems rarely reach a thickness of more than 3 or 4 millimeters, though they may entirely cover their supports more or less evenly for a length of 15 centimeters or more. In a few instances the surfaces of the specimens still bear evidences of a dermal film, which covered them when they were alive in the water, but in most cases this film has been broken away and the exposed areas reveal the fragile, open network of the parenchyma into which are crowded many gemmules.

Color.—There is very great differences in the color of the sponge depending upon the cleanness of the water in which it was growing. Annandale records black sponges in India changing to "pure white" in less than a week when taken from their natural habitat and put into clean, clear water. All of the Philippine specimens of *Ephydatia crateriformis* are either black or very nearly so. The gemmules are white or gray and contrast clearly with the sponge itself.

Structure.—The sponge is made up largely of irregularly shaped meshes into which are crowded a large number of gemmules. These meshes are weak, being composed of a small number of spicules, rarely more than three to five and often only one or two. The amount of spongin is also small and therefore the structure is very fragile. When the sponges are roughly

[15] Proc. Acad. Nae. Sci. (1882) 12–13.
[16] Treubia 12 (1930) 87–92.

handled or crushed the gemmules are liberated in large numbers and fall out of the parenchyma. In only one or two of the specimens are comparatively large oscula present.

Skeleton spicules.—The skeleton spicules are spindle shaped and sharp pointed, but in most cases instead of tapering gradually to a point, they are of almost uniform diameter to near the ends where they become abruptly sharp pointed. A few of them do taper gradually to sharp points. I find none of the spicules with rounded or with spearhead-shaped ends such as are characteristic of some forms of *Ephydatia crateriformis* found in other parts of the world. Generally the spicules are somewhat curved; rare straight ones do occur, however, and they bear a varying number of very fine spines; some of the spicules appear to be smooth and others bear such small spines that they can be seen only under the higher magnifications of the microscope, others bear larger numbers of spines which are clearly visible. The ends of the spicules are always free of spines. As a whole, however, the spicules of the Philippine sponge have as a rule much fewer spines than those of other sponges of this species from elsewhere. The spicules measure from 272 to 323 microns in length and from 12 to 14 microns in thickness.

Flesh spicules.—True flesh spicules are entirely lacking in this species.

Gemmules.—The gemmules are small, white in color, occur singly, and are usually crowded in great abundance throughout the whole body of the sponge. There are, in fact, in some of the specimens so many gemmules that the rather weak skeleton can hardly contain them and, when dry, any rough handling of them shatters out large numbers of the gemmules. They are covered by a coat of granular material in which a single layer of perpendicularly placed gemmule spicules are closely crowded together. Usually the gemmules are spherical, but in some cases they become somewhat elongated, pear-shaped, with the pore tube on the smaller end. The pore tube opens on the surface of the gemmule coat, but in many cases in my specimens the tube appears to have built up around it a mass of granular material with some spicules in this. The gemmules measure from 250 microns in diameter in the smaller ones to as much as 340 microns in the larger ones.

Gemmule spicules.—The gemmule spicules of this Philippine sponge are on the average shorter and more nearly uniform in length than are those from most of the other sponges of this

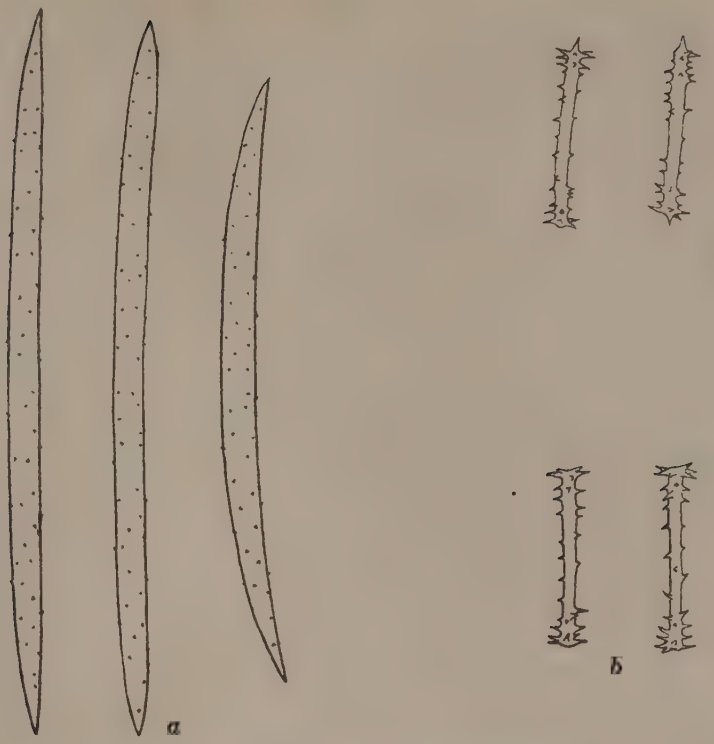


FIG. 4. *Ephydatia crateriformis*, spicules; *a*, spined skeleton spicules; *b*, gemmule spicules; some with sharp ends, others with rounded ends.

species with which I am familiar. They are generally straight, but some are slightly curved. The rotules are as a rule quite well formed by the ring of spines, often slightly recurved, around the ends of the spicules. While the blunt or rounded ends are largely characteristic, yet some of the spicules terminate in a prominent spine. The spines are in the main large, abundant, perpendicular, usually larger and more abundant near the ends of the spicules; some spicules are found, however, on which the spines are more or less evenly distributed over the whole length of the spicule. The spines are more numerous and proportionately heavier in the Philippine sponge than those in the American form of this sponge from the type locality. The spicules measure from 60 to 64 microns long and are from 4 to 5 microns in diameter.

Type.—The type of this species is in the collection of the United States National Museum, Washington, D. C.

Distribution.—*Ephydatia crateriformis* occurs in North America, where it is widely distributed; it has also been found in India, in Burma, on Ross Island, and in southeastern China. It is now recorded for the first time in the Philippine Islands from both Pinagbuhatan and Lamesa Dam, Novaliches, Luzon.

Remarks.—This Philippine sponge resembles some of the China representatives of this species more closely than it does the American ones. It is, however, a very variable sponge and the skeleton spicules in some of the various forms assigned to the species may have their ends rounded; or they may be irregularly shaped resembling spearheads; or they may be nearly cylindrical for most of their length and then abruptly pointed; or they may taper very gradually from the center to very sharp-pointed ends. A decided variableness is also noticeable in the distribution, the size, and the number of spines on the gemmule spicules; some have minute spines or may even be altogether smooth, while others bear prominent spines.

The gemmule spicules of this species are also extremely variable in the size, the number, and the arrangement of the spines on the spicule and in the degree of perfection of the rotule.

It would be difficult in most cases to separate out varieties which are constant enough and distinct enough for recognition. The writer has found and described one such variety, *Ephydatia crateriformis* var. *cantonensis*,[17] where the differences from the type form are both marked and constant.

EPHYDATIA FORTIS var. VORSTMANI Gee, 1930. Fig. 5.

Ephydatia fluviatilis var. *ramsayi* VORSTMAN, 1928.

Historical statement.—Dr. A. G. Vorstman first discovered this sponge and published a brief record of its occurrence in Java.[18] She called it *Ephydatia fluviatilis* var. *ramsayi*. The collection containing some of the specimens was sent to the writer and after a careful study of the sponge it was named as a new variety, *Ephydatia fortis* var. *vorstmani*, and in my paper on the fresh-water sponges of the Dutch East Indies [19] there is a full description of this sponge. There are in the collections from Pinagbuhatan three or four specimens which

[17] Bull. Peking Soc. Nat. Hist. 3 (1928–29) 1–4.
[18] De Tropische Natuur (1928) No. 7.
[19] Treubia 12 (1930) 94–98.

are placed in this variety. Though there are certain differences between the two sponges, yet intergrading forms are found which link the Java and the Philippine sponges together.

Habitat.—The smaller specimens were crushed and are in small pieces but the largest specimen in the Philippine collection is intact and was found growing around the small twigs of a plant; evidently it had grown in clear water for it is quite free from sediment of any kind. Vorstman (1928) stated that her Java specimens were solid in growth, forming round crust-shaped pieces with a diameter of 2 centimeters or more. The Java specimens were found growing exclusively on the surface of stones.

General characteristics.—The sponge was growing around the fine stems of a small portion of a branching plant and had a general, almost symmetrical appearance resembling somewhat the shape of a crab. Its shape was due altogether to the branching support upon which it had grown. The sponge measures about 13 centimeters in its longest part and is about 7 centimeters in its thickest portion. A cross section of a growth around one of the twigs is only about 2.5 centimeters in diameter. One surface of the sponge bears only the minute pores in very large numbers over the entire surface; on the other side are scattered some 18 or 20 conspicuous oscula opening level with the surface and entering into a much-branched system of canals within the sponge. The surface of the sponge is in places covered with green algal growths; these growths seem to be superficial, however, and do not penetrate deeply into the sponge tissue.

The surfaces of the Java sponges had rods and plaits formed by short protuberances which had grown together, giving them a very rough appearance. The Philippine sponges present smoother surfaces with only a few irregularities which are caused largely by the branches of the plant or a very small pyramidal growth now and then on the surface.

Color.—This specimen is a very light tan on the inside tinged with gray on the outer areas; over its surface are scattered a few patches of the green algal growths mentioned above. The gemmules are slightly darker in color than the sponge itself and have something of a yellowish tinge.

Structure.—That portion of the sponge immediately surrounding the small supporting sticks (which are in no case more than 2 or 3 millimeters in diameter) is composed chiefly of irregular

meshes into which are crowded large numbers of gemmules. Through this area there are visible a few radiating fibers but these become more regular beyond this inner area and extend in all directions to the surface of the sponge; these radii are quite distinct in the outer portion of the sponge and are composed of several of the heavy spicules bound together by a small amount of spongin; the transverse fibers are less regular but are present at intervals bracing the longer fibers, so that the entire structure is quite firm. The whole of the body of the sponge is penetrated by a well-organized system of canals.

Skeleton spicules.—The skeleton spicules are heavy, straight or only very slightly curved, spindle-shaped ones tapering gradually and becoming more or less abruptly sharp pointed at the ends. One gains the impression at first after an examination with a low-power objective that the spicules are smooth, but closer examination with higher powers reveals very minute spines scattered thinly over the spicule. Now and then spicules are found which bear more numerous and more prominent spines but these are rare. They vary in length from 298 to 382 microns, most of them being around 340 to 350 microns long; in thickness they range from 17 to 24 microns.

Flesh spicules.—Flesh spicules are lacking in this sponge.

Gemmules.—The gemmules occur singly but in fairly large numbers in the inner portion of the sponge; as a general thing they are more abundant right around the support and close to it than they are in the outer part of the sponge. They are a light tan tinged with light yellowish, being only a little darker than the sponge itself. The spherical gemmules, when dry, have one half sunken in forming a bowl-like depression and generally the pore tube opens in the middle of this depression as a simple tube with only a slightly funnel-shaped termination on the surface of the gemmule. The gemmule is covered by a single, more or less regularly arranged layer of perpendicularly placed gemmule spicules embedded in the coat of granular substance around its entire surface. The outer surface of the coat has a pitted appearance, the pits being caused by the outer rotules of the birotulates which are almost even with the outer surface of the gemmule coat. The gemmules are very variable in size, ranging from 467 to 637 microns and averaging around 510 to 540 microns in diameter.

Gemmule spicules.—The gemmule spicules are birotulates of varying length, the extremes varying from 46 to over 70 microns,

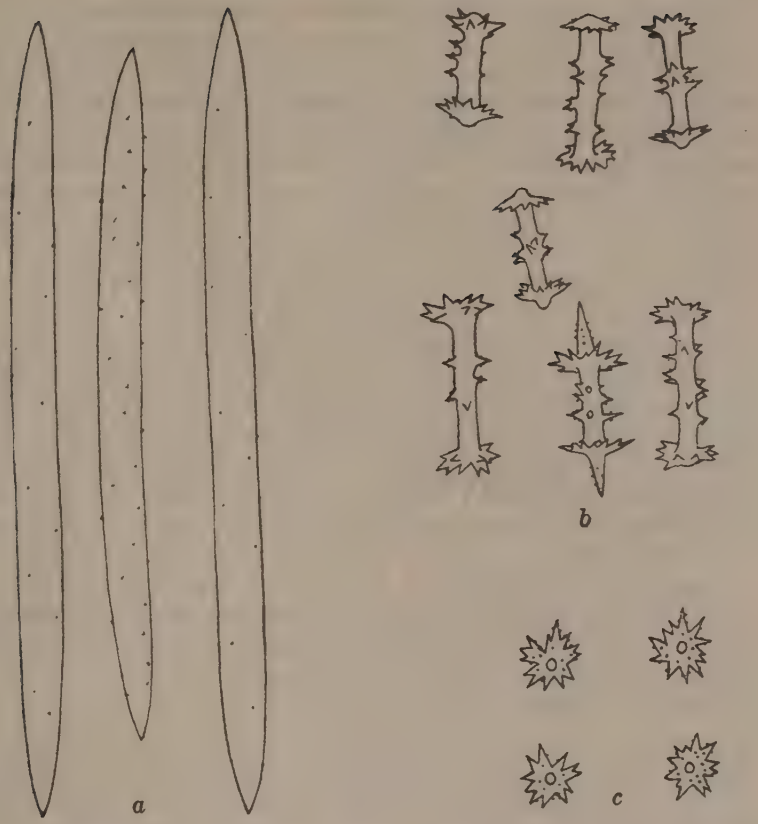


FIG. 5. *Ephydatia fortis* var. *vorstmani*, spicules; *a*, skeleton spicules; some almost smooth, some with larger numbers of minute spines; *b*, gemmule spicules, showing the wide range of variation in size and in arrangement of spines on the shafts of the various types; *c*, rotules or disks, showing indentations in edges; these bear very minute spines.

though the average is between these. The shafts are heavy, measuring 9 or 10 microns in diameter; the rotules are about equal and range from about 24 to 29 microns in diameter. The rotules are incised into coarse teeth and these are often finely spined near their tips. The shaft projects slightly beyond the plane of the rotule, forming small rounded knobs at each end of the birotulate; in a few cases this knob becomes elongated into a heavy, long, sharp spine at one or both ends. The shaft is provided with a variable number of heavy, conical, perpendicular spines which in turn bear small spines near their ends. Usually

these heavy spines are more abundant around the central part of the shaft. The shaft spines may be simple or compound and may vary greatly in number and in size; some birotulates may have only three or four spines arranged nearly in a circle around the center of the shaft, others may have a large number of spines scattered irregularly along most of the length of the shaft; in most cases the spines do not occur close to the rotules; a rare spicule may now and then be found without any spines on its shaft.

Type.—The type of this variety is preserved in the collections of the Zoölogical Museum in Buitenzorg, Java.

Distribution.—So far, this variety has been found in Java in Klakah Lake and in Pakis Lake. The type form of this species, *Ephydatia fortis,* was originally described from the Philippines (Libmanan River, Luzon), and now we report the finding of the variety *vorstmani* in the collection made in Pinagbuhatan in January, 1932. Another variety of this species, *Ephydatia fortis* var. *hebridensis,* has been found in the New Hebrides Islands.

Remarks.—This sponge is definitely of the *Ephydatia fortis* group and resembles most closely the variety which the writer has described from Java, *Ephydatia fortis* var. *vorstmani.* It differs from that variety in the following details:

SKELETON SPICULES

1. Those of the Philippine sponge are in most cases either smooth or very sparsely covered with very minute spines; while those of the Java sponge are usually thickly covered with larger spines except near their ends.
2. Those of the Philippine sponge are more nearly straight than those of the Java sponge.

GEMMULE SPICULES

1. The gemmule spicules of the Philippine sponge are more normal and more regular in their development and have a more constant arrangement of the spines near the central area of the shaft than is the case in the spicules of the Java sponge.

Upon the first hurried examination of the Pinagbuhatan sponge, it seemed to be a form quite distinct from any *Ephydatia* with which the writer is familiar, but later careful comparisons of it with the Java sponge, *Ephydatia fortis* var. *vorstmani,* have convinced me that these two sponges, whose extremes are quite unlike, are connected by intervening links. While possibly the extreme forms of these two sponges are definite enough to merit varietal distinction in themselves, yet

since it is possible to connect these extremes by a series of forms linking them together, a new varietal distinction cannot be made.

The variation of the skeleton spicules in these sponges presents a case similar to that of the sponges formerly known as *Ephydatia mulleri* and *E. japonica*, which are now considered as one species.

DOSILIA PLUMOSA (Carter), 1849. Figs. 6 and 7.

Spongilla plumosa CARTER, 1849.
Meyenia plumosa (CARTER), 1881.
Ephydatia plumosa WELTNER, 1895.

Historical statement.—Carter [20] described *Dosilia plumosa* from Bombay, India, and, many years later, revised his first description.[21] Specimens were submitted to Bowerbank and he published his description in 1863.[22] Potts quotes Carter's description in his monograph of the known sponges.[23] Annandale [24] redescribed the species in 1911. In this place he records having found this species at Rhambha in the northeast of the Madras Presidency.

I have now found this sponge in the material submitted to me by Mr. McGregor for examination both from Pasig River, near Manila, and from Pinagbuhatan, Rizal, Luzon, P. I. There was only a small fragment of the sponge in the Pasig River collection and it was at first overlooked, but after it had been found in three or four small bits in the Pinagbuhatan collection, the one small specimen was readily picked out of the accumulated "scraps" from the Pasig River collection.

In 1885 Potts described a variety, *palmeri*, of this species from the Colorado River, near Lerdo, Sonora, in northwestern Mexico, in the Proceedings of the United States National Museum; and Traxler in 1895, in Földtani Közlony, found the spicules of this variety in some alluvial soils from near São Paulo, Brazil.

In 1906, Kirkpatrick described another variety, *brouini*, from the White Nile River about two hundred miles north of Khartum, Africa.

[20] Ann. & Mag. Nat. Hist. II 4 (1849) 85.
[21] Ann. & Mag. Nat. Hist. V 7 (1881) 94.
[22] Proc. Zool. Soc. London (1863) 449.
[23] Proc. Acad. Nat. Sci. Philadelphia (1887) 233.
[24] Fauna British India, Freshwater Sponges, Hydroids, & Polyzoa (1911) 111–113.

Habitat.—All of the small bits of this sponge which were found in the Philippine Islands collections except one were broken loose from their supports. The one small specimen was growing around a twig. I have no information concerning the place where these specimens were found. Carter found his specimens in tanks; Annandale found his in a pool of slightly brackish water.

General characteristics.—The specific name, *plumosa,* is descriptive and indicates the general feathery appearance of the sponge when it is growing freely. This was very characteristic of two or three of the small specimens, while one somewhat

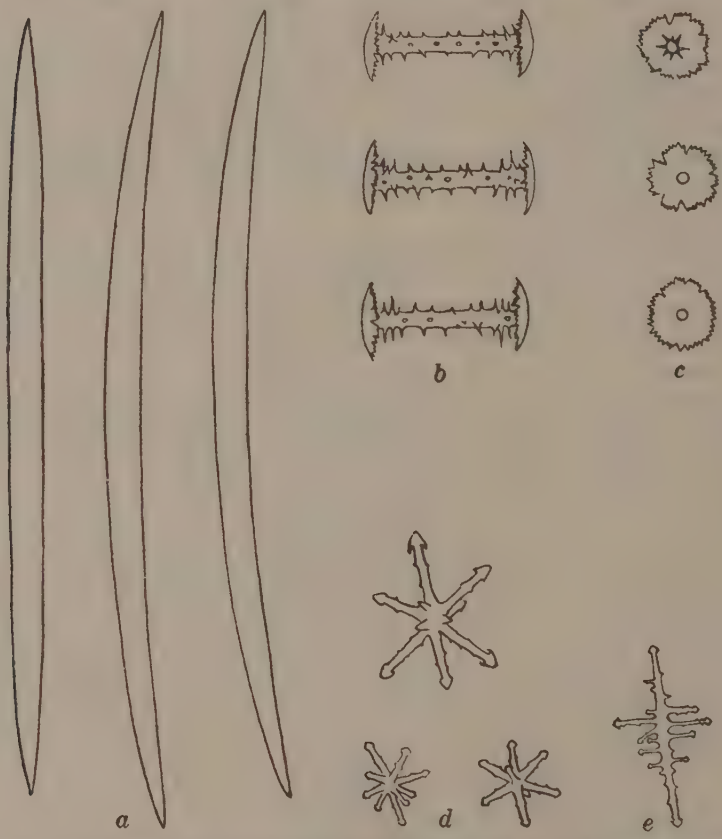


FIG. 6. *Dosilia plumosa,* spicules; *a,* skeleton spicules, smooth and sharp; *b,* gemmule spicules (birotulates), showing arrangement of spines on shaft; *c,* disks, showing indentations of edges; *d,* various types of the peculiar stellar flesh spicules; *e,* flesh spicule with one long main axis.

larger piece had evidently been mashed together while still wet into a compact mass. The largest specimen in the lot was growing around a small branched twig and covered it with an open, loose and, when dry, very brittle sponge for a length of about 6.5 centimeters. Its greatest diameter was something less than 2 centimeters in the center, and it tapered off to a thin covering of its support at each end. The one branch of the twig was also similarly covered by the sponge. Gemmules were scattered irregularly all through the sponges.

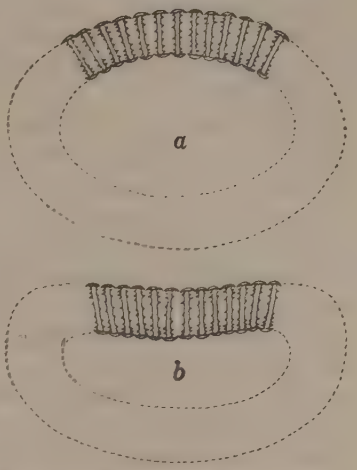


FIG. 7. *Dosilia plumosa*; diagrammatic sections of two types of gemmules, showing arrangement of birotulates which cover them.

Color.—Carter's Bombay specimens were some green and some yellow; Annandale's were of a pale brown or a brilliant green. The Philippine specimens are all green. The difference in color is doubtless due to whether or not the position of the sponge is favorable for the growth of the algæ which are the cause of the color.

Structure.—The skeletal structure of this sponge is unique. The radiating fibers are prominent and divide frequently in such a manner that they form a loose featherlike growth with a good deal of open space in it. These radiating fibers are formed of several spicules tightly bound together by an abundance of spongin and the fibers often extend to the surface of the sponge where they end in points, thus giving the surface of the sponge a hispid appearance. The smaller cross fibers binding the larger ones together are not nearly so conspicuous as the main ones.

Skeleton spicules.—The skeleton spicules are spindle-shaped, thicker in the center and gradually tapering to sharp points at each end. They are smooth and usually gently curved, though at times straight. The mature spicules vary from 416 to 527 microns in length and from 14 to 20 microns in diameter in the center. There are also a number of smaller smooth spicules, thinner and shorter, scattered throughout the parenchyma of the sponges; these are doubtless immature skeleton spicules.

Flesh spicules.—The flesh spicules are scattered in great abundance throughout the sponge, but seem to be especially numerous around the gemmules. The most common form of this spicule, which is the characteristic upon which the genus is founded, is an irregularly stellate one. There are often as many as eight to twelve or more rays of varying length projecting from a distinct central nodule. The radii vary considerably in length; some barely project beyond the surface of the central nodule, others seem to form a regular axis running straight through the nodule and measure as much as 36 microns from one end to the other. Most of the stellate spicules are smaller than this. These rays may be smooth or may bear small spines and end in slightly enlarged nodules bearing small recurved spines, sometimes forming an indefinite rotule. There is very great variation in these spicules and some rare ones are found which are straight, heavily spined ones with one or more large "spines" or branches projecting at right angles to the length of the spine; these do not have the central nodule. In other cases the stellate forms seem to be built upon such a straight spicule by adding the nodule around the perpendicular branches. It seems that the unique stellate form of spicule may have evolved from the straight one and doubtless it would be possible, by examining a very large series of slides, to discover the various stages of such an evolution.

The spines on the rays of the Indian sponge and at their ends are much larger and more abundant than those in the Philippine one.

Gemmules.—The gemmules occur singly and are scattered irregularly throughout the skeleton of the sponge. In my specimens they are fairly abundant. They are elliptical or ovoid in shape and, when dry, become flattened laterally. The pore tube, as a rule, is in the center of the flattened side and is a simple tube through the gemmule coat. The entire surface of the gemmule is covered by a granular coat in which are embedded a single layer of the long perpendicularly placed birotulates, with one rotule resting on the gemmule surface and the outer one forming part of the outer surface of the gemmule coat. Five gemmules chosen at random gave the following measurements in microns: 705 by 450.5, 688.5 by 450.5, 663 by 561, 765 by 450, 646 by 382.5.

Gemmule spicules.—The gemmule spicules are birotulates with rotules equal in size and very similar in structure. The disks

are curved, concavo-convex, with the concave side toward the shaft. They are incised around their edges into numerous small, rather blunt, toothlike projections, which are slightly curved inward toward the shaft. The shaft is cylindrical, long, straight, rarely gently curved, and of almost uniform diameter except at the ends where it becomes swollen, trumpetlike, as it joins the rotules. It is covered with numerous spines throughout its length right up to the rotules. These spines are conical and sharp pointed and vary in size from very small ones to others with a length even greater than the diameter of the shaft itself. As a rule the spines in the center of the shaft are shorter than those near the rotules.

In the Indian sponge the shaft, as a rule, bears fewer and heavier spines; also the spines are generally located more toward the center of the shaft while the ends near the rotules are freer from them. The variation in length of the spicules is more marked in the Indian than in the Philippine sponge.

The spicules vary in length from 66 to 80 microns (the Indian sponge varies from 50 to 86 microns) and in thickness from 3 to 4 microns. The rotules vary from 23 to 25 microns in diameter.

Type.—Carter's type of this species from Bombay, India, is preserved in the British Museum in London, England.

Distribution.—As stated above, the type form of this sponge has, up to the present, been found only in Bombay and in Rhambha, near Madras, India. This being the case, the finding of this species in the Philippine Islands is of great interest. Doubtless it will be found later in the intervening areas. The two Philippine localities, Pasig River, near Manila, and Pinagbuhatan, Rizal Province, are not far apart. We will study with great interest additional collections from other more-distant localities, for doubtless there is a very rich and varied fresh-water sponge fauna in these Islands.

The two other described varieties of this sponge (Annandale, 1911, considered them as species) are from a very wide range of localities; *brouini* from the White Nile in Africa and *palmeri* from Sonora, Mexico, and from São Paulo, Brazil.

Remarks.—There are certain minor differences between the Indian sponge and the one from the Philippines. I have noted these above, but do not think them constant enough or so marked as to warrant the creation of a new variety. I find such great variation in sponges that I am more inclined now than I formerly

was to "lump" rather than to "split" forms. It seems, however, in our present imperfect knowledge of the distribution of sponges that it may be wise to have some system of nomenclature in this group similar to the trinomial system in use in some other phyla to indicate widely isolated forms which show even slight variation from the type forms.

TROCHOSPONGILLA LATOUCHIANA Annandale, 1907. Fig. 8.

Historical statement.—This species was originally described and illustrated by Annandale.[25] The type specimen was collected in the tank of the Indian Museum in Calcutta. Since that time the species has been found rather widely distributed in the Orient, and it has been redescribed a number of times by different authors. Annandale's description in his Fauna of Indian volume (1911) and the present writer's description [26] give full information concerning the sponge.

A variety of this species, *Trochospongilla latouchiana* var. *pasigensis,* has already been described.[27] This differs considerably from this typical form which is now reported for the first time from the Islands.

Habitat.—This sponge is very common in Kiangsu and Chekiang Provinces, on the eastern coast of China, and is found growing in thin layers on all kinds of supports; such as, stones, wooden piles, and plant stems. It is very common in some localities in the canals where the water has some current. The specimens collected in Pinagbuhatan had grown on plant stems, usually small ones, or small twigs and formed typical colonies entirely covering the support.

General characteristics.—There are almost no differences in general appearance between the Philippine specimens and those from China except in the supports upon which they grow. The specimens in this Philippine collection cover plant stems or twigs, while most of the China ones grew on stones. In one of the Philippine specimens the sponge covered a flattened stick over 24 centimeters long by 3.5 by 1.5 centimeters with a uniform growth varying from 2 to 3 millimeters in thickness. In one small specimen the sponge is as much as a centimeter thick. In practically all of our China specimens of this sponge, there is present a large number of white gemmules; the gem-

[25] Journ. Proc. Asiatic Soc. Bengal n. s. 3 (1907) 21–22.
[26] Treubia 12 (1930) 98–101.
[27] Philip. Journ. Sci. 48 (1932).

mules are less abundant in the Philippine Islands specimens and are altogether lacking in some of them. The surface of the sponge when dry is hispid and suggests the surface of velvet. The pores are inconspicuous, but there are a number of branching canals running back and forth within the sponge; these can be clearly seen from the surface of the dried sponge.

Color.—The general color of these sponges is brown, varying from a lighter brown in the cleaner specimens to a darker color in those which contain more sediment. It is evident that sponges growing in clean water free from sediment would be light brown. The gemmules are white.

Structure.—The skeleton of this sponge is made up of clearly defined, stout fiber rays consisting of several spicules placed perpendicularly to the support, branching repeatedly, continuing to the surface of the sponge and terminating in sharp points

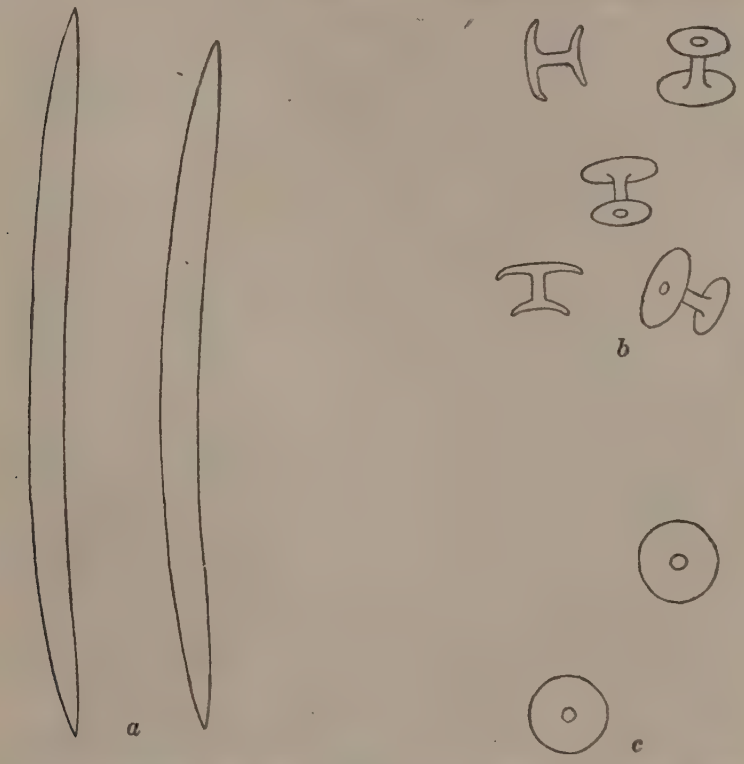


FIG. 8. *Trochospongilla latouchiana*, spicules; *a*, smooth, gently curved skeleton spicules; *b*, gemmule spicules with edges of the disks upturned; *c*, smooth-edged disks.

which give the sponge its velvety appearance. The spongin is moderate in amount, but it binds the fibers tightly together and gives a rigidity to the entire structure. The transverse fibers are less regular and are thinner than perpendicular ones.

Skeleton spicules.—The skeleton spicules are usually gently curved, rarely straight, smooth, spindle-shaped, being thicker in the center and gradually tapering to sharp points at each end. They are, as a rule, from 246 to 297 microns in length and from 10 to 15 microns in diameter. The slide preparations have now and again a few spicules as long as 332 microns and as thick as 20 microns; it seems likely that these are the spicules from another sponge, possibly *Spongilla carteri,* mixed with those of *Trochospongilla latouchiana.*

Flesh spicules.—This species does not have any flesh spicules.

Gemmules.—The gemmules are white, small, and nearly spherical. They are scattered singly throughout the meshes of the sponge and have no definite arrangement. The pore tube is simple and opens through the single layer of birotulates, sometimes with this layer arranged into a craterlike structure around its opening. The birotulates are perpendicularly placed with the larger rotule resting upon the surface of the gemmule, the rotules being so crowded together that their edges may even overlap a bit at times. The smaller rotules are about even with the outer surface of the gemmule coat and frequently cause it to have a pitted appearance because of the curved rotule. The gemmules of Philippine sponges will probably average somewhat smaller than the China ones, but the range of variation in diameter is very nearly the same; they measure from 174 to 196 microns in diameter.

Gemmule spicules.—The gemmule spicules are collar-button-like birotulates bearing flattened disks of unequal size and with their edges turned up in a saucerlike manner. The shaft is small, slender, and free from spines; it becomes slightly enlarged toward each end as it joins the disks. The length of the spicules varies from 16 to 17 microns, outside measurement. This length is more constant and closer to that of the typical form in the Philippine sponges than is the case in a great many of the Chinese sponges of this species. The upper rotule is from 14 to 15 microns in diameter, and the lower one is about 18 microns; the shaft is approximately 3 microns thick.

Type.—The type of this species is kept in the Indian Museum, Calcutta, India.

Distribution.—*Trochospongilla latouchiana* has been previously reported from Calcutta and neighborhood, lower Bengal, India; from Kawkareik, Lower Burma; from the Botanical Garden in Buitenzorg and from a lake at the station of Tjitajam in West Java; also from Galapan Lake in East Java; from several places in both Kiangsu and Chekiang Provinces in east-central China. From the materials in this collection now under study the range is being extended to the Philippine Islands. There are several specimens of this species in the collections made in Pinagbuhatan, Rizal, Luzon, but it has not yet been found at the other places from which collections have been made.

Remarks.—It seems quite likely that this sponge will be found to occur under suitable conditions in most of the region between India and the Philippine Islands when careful studies of that region have been made. Forming, at it does, thin inconspicuous coverings upon its supports, it is likely to be overlooked except by experienced collectors. The range of this species in China so far as we now know it is rather interesting; Nanking in the southern part of Kiangsu is its northern limit and the southern portion of Chekiang Province is its southern limit. Collections have not been made in the interior provinces of China, and we may yet find that the distribution is more general and covers a much wider range than is indicated from our present knowledge.

TROCHOSPONGILLA PHILLOTTIANA var. TUNGHUENSIS Gee, 1926. Fig. 9.

Trochospongilla tunghuensis GEE, 1926.

Historical statement.—*Trochospongilla phillottiana* was first described and illustrated by Annandale,[28] from specimens collected in the tank of the Indian Museum in Calcutta, India. The variety *tunghuensis* of the type species was described by the writer from material secured from Tung Hu (East Lake), near Ningpo, China, in 1925. A brief description first appeared in 1926;[29] since that time several redescriptions of the variety have appeared, the last in the writer's monograph on the genus *Trochospongilla.*[30]

Habitat.—This sponge has only been found in China occurring on colonies of other sponges. It is very rare and was found in several cases around the edges on the underside of pieces of

[28] Journ. Asiatic Soc. Bengal n. s. 3 (1907) 22–23.
[29] China Journ. Sci. and Arts (1926) 171.
[30] Peking Nat. Hist. Bull. 6 pt. 2 (1932) 1–32.

Spongilla fragilis which had been collected on the Van Nyien Jao, Soochow. The related variety, *javanensis*, was found growing in very small patches on small rootlets in Rawah Bening, East Java. The Philippine representatives were collected in Pinagbuhatan, Rizal, growing on fine rootlets or twigs.

General characteristics.—The colonies of this species found in Pinagbuhatan are the largest that I have seen; they form small nodules from 1 to 2 centimeters in length and have a thickness of 2 to 3 millimeters in the center of the colony all around the support and become thinner until they end in a mere film covering the support. If the twig has a diameter of 3 or 4 millimeters, then the sponge colony may measure as much as 2 centimeters in length and 6 to 8 millimeters, or slightly more, in diameter in its thickest part. The surface is smooth.

Color.—When dry, these sponges are gray with a slight brownish tinge; some of them have a dirty white appearance.

Structure.—The colonies are so small and so thoroughly crowded with gemmules that the sponge shows no distinguishing structure; the irregular system of meshwork seems woven together simply to hold the gemmules in place and there are no distinct, continuous fibers which extend throughout the sponge. The spicules are short and the fibers are thin and irregular, composed usually of only a very few spicules held together by a small amount of spongin. The whole structure is fragile and crumbles very easily.

Skeleton spicules.—Most of the skeletal spicules are curved, straight ones are very rare, thickly covered all over, even to the very tips, with very fine, sharp spines. The spicules are mainly splindle-shaped, some of them slender, measuring only 4 to 5 microns in diameter and tapering very gradually to sharp-pointed ends; others are thicker, measuring up to 13 microns, and of a more uniform diameter throughout most of their length, but abruptly sharp pointed or in some few cases with nearly rounded ends except that there is a small sharpened point at the tip. The spicules vary in length from around 153 to 192 microns.

Flesh spicules.—There are no flesh spicules in this species.

Gemmules.—The nearly spherical gemmules are white, occur singly, and are crowded through most of the sponge body. They are covered with a more or less translucent jellylike substance, which forms a very irregular "bubbly" coat over the entire surface of the gemmule giving it a pitted appearance.

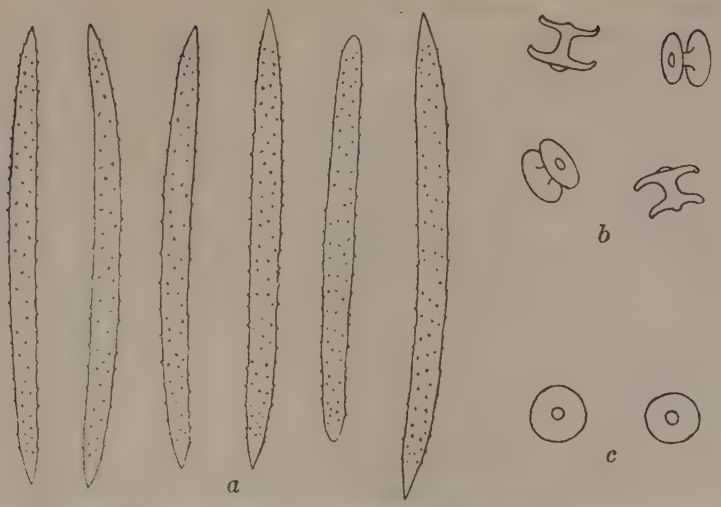


FIG. 9. *Trochospongilla phillottiana* var. *tunghuenis*, spicules; *a*, sharp-pointed, spined skeleton spicules; *b*, small birotulates with curved disks and small umbos; *c*, circular disks with smooth edges.

In this are embedded numerous dark-colored particles which may be minute unicellular algæ. Inside this outer coat, there is a single layer of gemmule spicules arranged so closely together that their rotules often overlap. The pore tube is simple. The gemmules are all dry and, in most cases, one-half of them is shrunken in forming a bowl-like structure. The gemmules vary from 255 to 273 microns in diameter when naked, but when including the jellylike covering they measure from 270 to 323 microns in diameter.

Gemmule spicules.—The gemmule spicules are small birotulates with a comparatively thin shaft and smooth-edged rotules; the rotules are large for the size of the spicule and are of more nearly equal diameters than are those of *Trochospongilla latouchiana*. The lower rotule or disk is usually slightly larger than the upper one; both rotules are curved upward around their outer edges forming saucerlike disks, sometimes their edges are a bit sinuous. The shaft forms a very small knob on the outer surfaces of the disks. The length of the spicules is about 10 to 12 microns; the diameter of the upper rotule is from 16 to 17 microns and that of the lower one slightly greater, from 17 to 20 microns.

Type.—The type of this variety is No. 53666 in the writer's collection.

Distribution.—It seems quite likely that this sponge and its related forms may be quite widely distributed over the area between India, Japan, and the Philippine Islands. Up to date this special variety has been recorded from the following places in China: East Lake (Tung Hu), near Ningpo, Chekiang Province; Soochow and Nanking, both in Kiangsu Province; and Tung Ting Lake, near Yochow, Hunan Province. It has also been found by the writer in Lake Biwa, Japan. Now this interesting collection from Pinagbuhatan is also found to contain it. A closely related variety, *javanensis*, of this species has been found in Java. The type form, *Trochospongilla phillottiana*, is known only from Calcutta, India, and the writer has described a very small variety, *minima*, of this species from Kawkareik in lower Burma.

The sponge colony is so minute in size that it is easily overlooked and only experienced collectors are likely to notice it. When a more careful and detailed study of the sponge fauna of this region is made doubtless many of the smaller forms which are now overlooked will be brought to our attention.

Remarks.—In the sponges of this variety, both from China and from Japan, there are a number of skeleton spicules with distinctly rounded ends, but in the Philippine representatives of this group I have not found more than five or six skeleton spicules without the trace of a sharp point at their ends. In those sponges where both the sharp and the round-ended spicules occur, nearly always the sharp-pointed ones average somewhat longer than those with round ends.

Trochospongilla phillottiana var. *minima* from Burma has markedly smaller spicules, both skeletal and gemmule, than any of the others of the *Trochospongilla phillottiana* group, but the other forms, while there are variations one from the other, yet closely resemble each other in the dimensions of their skeletal and gemmule spicules. It is probably better for the present to maintain the described varieties; it will be noticed that all the sponges of this group from China, Japan, and the Philippine Islands are placed in the same variety, *tunghuensis*.

ILLUSTRATIONS

[Drawings by Y. C. Su, made under the direction of Dr. C. F. Wu, of Yenching University.]

TEXT FIGURES

FIG. 1. *Spongilla proliferens*, spicules; *a*, smooth skeleton spicules; *b*, gemmule spicules, showing heavy, recurved spines near the ends and the divided or multiple-pointed spines in the middle area of the spicules; *c*, the small sharp-pointed flesh spicules.

2. *Spongilla carteri*, spicules; *a*, smooth skeleton spicules; *b*, very similar, but smaller, gemmule spicules.

3. *Spongilla fragilis* var. *decipiens*, spicules; *a*, smooth skeleton spicules, abruptly sharpened; *b*, longer gemmule spicules, showing various shapes and the variety in the size and arrangement of the spines; *c*, shorter gemmule spicules.

4. *Ephydatia crateriformis*, spicules; *a*, spined skeleton spicules; *b*, gemmule spicules; some with sharp ends, others with rounded ends.

5. *Ephydatia fortis* var. *vorstmani*, spicules; *a*, skeleton spicules; some almost smooth, some with larger numbers of minute spines; *b*, gemmule spicules, showing the wide range of variation in size and in arrangement of spines on the shafts of the various types; *c*, rotules or disks, showing indentations in edges; these bear very minute spines.

6. *Dosilia plumosa*, spicules; *a*, skeleton spicules, smooth and sharp; *b*, gemmule spicules (birotulates), showing arrangement of spines on shaft; *c*, disks, showing indentations of edges; *d*, various types of the peculiar stellar flesh spicules; *e*, flesh spicule with one long main axis.

7. *Dosilia plumosa;* diagrammatic sections of two types of gemmules, showing arrangement of birotulates which cover them.

8. *Trochospongilla latouchiana*, spicules; *a*, smooth, gently curved skeleton spicules; *b*, gemmule spicules with edges of the disks upturned; *c*, smooth-edged disks.

9. *Trochospongilla phillottiana* var. *tunghuensis*, spicules; *a*, sharp-pointed, spined skeleton spicules; *b*, small birotulates with curved disks and small umbos; *c*, circular disks with smooth edges.

RECENT AND FOSSIL SHELLS FROM THE PHILIPPINE ISLANDS, I

By LEOPOLDO A. FAUSTINO

Of the Bureau of Science, Manila

TWO PLATES

This is the first of a series of papers on Recent and fossil shells of the Philippine Islands, and is for the purpose of describing and figuring new or interesting shells, also those contained in the writer's Summary of Philippine Marine and Fresh-water Mollusks [1] and in his Summary of Philippine Land Shells,[2] and other shells which have recently been collected or aequired by purchase or exchange and now form part of the conchological collection of the Bureau of Science together with fossil forms which have been collected by the Bureau of Science and other scientific institutions. Original descriptions of shells first described from the Philippine Islands will be given whenever they are available to the writer, with notations on the type locality. The geographic and geologic range of the genera and some of the species will also be given. It is the aim to make this series useful to the amateur, the professional conchologist, and the palæontologist.

In the preparation of this series the writer has received help from all sources, but he wishes to make special acknowledgment of the help given him by Dr. Paul Bartsch, curator of Cenozoic invertebrates, United States National Museum, Washington; Mrs. Ida S. Oldroyd, curator of the Conchological Museum, Leland Stanford Junior University, California; the British Museum of Natural History and Mr. H. C. Fulton, London; Dr. B. Rensch, of the Zoologisches Museum der Universität Berlin; Dr. F. Haas, of the Senckenberg Museum, Frankfurt-a-Main; Dr. B. Prashad, of the Zoological Survey of India, Indian Museum; and the Australian Museum, Sidney.

[1] Bur. Sci. Mon. 25 (1928) 1–384.

[2] Philip. Journ. Sci. 42 (1930) 85–198.

To the long list of references on Philippine shells given in the writer's enumeration, the following should be added:

16a.[3] In American Journal of Conchology, George W. Tryon, Jr., published two papers which describe two Philippine shells.

Descriptions of new species of Melania 1 (1865) 216–218.
Descriptions of new species of Amnicola, Pomatiopsis, Somatogyrus, Gabbia, Hydrobia, and Rissoa 1 (1865) 219–222.

28a. In the Proceedings of the Malacological Society of London the following papers were published:

On some new species of Melania from Palawan and the neighborhood 1 (1893) 175–177. A Brot.
On Monodonta quadrasi n. s., belonging to the subgenus Austrocochlea, from the Philippine Islands 3 (1898) 9. G. B. Sowerby.
Description of Tridacna obesa n. s., from the Philippines 3 (1898) 210. G. B. Sowerby.
Description of new species of marine mollusca collected by the late Otto Koch at the Island of Cebu 4 (1900) 126–129, 208–211. G. B. Sowerby.
Note on the opercula of Turbo pulcher Reeve and T. ticaonicus Reeve 5 (1902) 12. G. B. Sowerby.
Descriptions of new species of land shells from Peru and Colombia and two new species of Curvella from the Philippine Islands 7 (1906) 97–99. S. I. da Costa.
Notes on the shells of Tridacna, and description of a new species 10 (1912) 30. G. B. Sowerby.
On a collection of Pelecypoda from the Philippine Islands 12 (1916) 12–19. E. A. Smith.
Descriptions of new species of Mollusca belonging to the genera Drillia, Clavatula, Epitonium, Cantharidus, Bittium, Fissurella, and Cardium 12 (1916) 74–76 G. B. Sowerby.

32b. The latest contributions of Paul Bartsch to Philippine conchology are, New and old land shells from the Island of Luzon, Philippines, No. 2848, Proc. U. S. Nat. Mus. 78 (1930) 1–20, pls. 1–9; The tree snails of the genus Cochlostyla of Mindoro Province, Journ. Washington Acad. Sci. 22 [12] (1932) 335–344; The Philippine land mollusks Cochlostyla rufogaster and Obba marmorata and their races, Bull. U. S. Nat. Mus. 100, 6 [7] (1932) 329–342, pls. 83–86.

33. In the Proceedings of the United States National Museum, 57 (1921), W. H. Dall in his, Annotated list of the Recent Brachiopoda in the collection of the United States National Museum.

[3] Numbers refer to those used in the Introduction to Bureau of Science Monograph 25.

described 14 new species of brachiopod shells from the Philippines.

34. Bryant Walker published his, Notes on certain Philippine species of Viviparus, in Nautilus (April, 1919) 1–16.

35. One of the Occasional Papers of the Boston Society of Natural History is, Land shells from Lubang Island, Philippines, by William J. Clench and Allan F. Archer 5 (1931) 333–339, pl. 17.

36. The Director of the Zoölogical Survey of India published several important papers relating to the molluscan fauna of the Philippines. These are B. Prashad's Recent and Fossil Viviparidae, Memoirs of the Indian Museum 8 (1928) 153–252, 1 pl. and Revision of the Asiatic species of the genus Corbicula III. The species of the genus Corbicula from China, South Eastern Russia, Tibet, Formosa, and the Philippine Islands, Memoirs of the Indian Museum 9 (1929) 49–68, 2 pls.

37. Systematic works on Philippine fossil shells to the present time are few. The following may be considered the most important:

Francisco Antonio Llanos, Fósiles marinos de Filipinas, Revista de los progresos de las ciencias 13 (1863). (Not seen.)

K. Martin, description of *Vicarya callosa* var. *semperi* Martin in "Concerning Tertiary Fossils in the Philippines," Sammlungen des geologischen Reichs-Museums in Leiden 5 (1896) 68–69, translated by George F. Becker as a complement to his paper, Geology of the Philippine Islands, Ann. Rept. U. S. Geol. Surv. 21[3] (1901) 643–644.

Warren D. Smith, Preliminary geological reconnaissance of the Loboo Mountains, Batangas Province, Philip. Journ. Sci. 1 (1906) 628–631.

Warren D. Smith, Contributions to the stratigraphy and fossil invertebrate fauna of the Philippine Islands, Philip. Journ. Sci. § A 8 (1913) 255–280.

I. Hayasaka, Magellania dickersoni, a new species of brachiopod, Philip. Journ. Sci. 27 (1925) 61.

DESCRIPTION OF SPECIES

Family ARCIDÆ Dall

ARCA BINAKAYANENSIS sp. nov. Plate 2, figs. 1 and 2.

Shell nearly square, thick, inequivalve, left valve extending beyond the right valve, sides angulated at the upper part, anterior somewhat rounded, posterior almost a right angle. White, covered with a thin brown scaly epidermis, which comes off

easily, radiately ribbed, ribs 34, flat, fairly smooth, a few on the left valve somewhat larger than those on the right valve.

Length, 45 to 55 millimeters; height, 40 to 50.

Type.—No. 14046, Bureau of Science.

Locality.—Binakayan, Cavite, Philippines.

This is one of the common species sold in the Manila markets, and the Bureau of Science has hundreds of specimens. The type specimen was collected from the type locality by Florencio Talavera, of the division of fisheries, Bureau of Science. This species may be distinguished from *Arca cepoides* Reeve, its nearest ally, by the nearly right-angled posterior end and by its thicker shell.

Family OSTREIDÆ Lamarck

Genus OSTREA Linnæus

OSTREA IREDALEI sp. nov. Plate 1, figs. 1 to 4.

Shell somewhat variable in shape, depending largely on the object and mode of attachment. Those growing in bunches are elongate, sometimes tongue-shaped. Others are subtrigonal obliquely subtrigonal, sometimes oblong. Very foliaceous, and with a prominent beak.

Lower or left valve excavated, generally with a purple tint. Upper valve smaller, thinner, flatter, generally yellowish brown, sometimes with faint radiating rays of purple, covered with thin laminæ, scaly at the margins.

Hinge toothless, valve margins inside smooth. Shell interior chalky white. Muscle scar purple, located near the center.

Length, 30 to 80 millimeters.

Type.—No. 13594, Bureau of Science, collected by Florencio Talavera at Navotas, Rizal.

Locality.—Navotas, Malabon, Parañaque, and other places on Manila Bay.

Cotype.—No. 14259, Bureau of Science, collected by Florencio Talavera, at Parañaque, Rizal.

This species is the commonest oyster found near Manila and the one generally encountered in the Manila markets. I strongly suspect that this is the species referred to by Seale [3] as *Ostrea orientalis* Chemnitz, although as described by Dillwyn *O. orientalis* has a "shell about an inch and three quarters long, and an inch and a half broad." Unfortunately, the specimens of Seale

[3] Philip. Journ. Sci. § D 7 (1912) 273–281.

could not be located in the Bureau of Science. Reeve's Conchologia Iconica mentions *O. orientalis* Chemnitz as "species not identified." The conchologist of the Australian Museum, Sidney, was the first one to call my attention to the fact that the commonest Manila oyster appears to be an undescribed species, very well characterized by the purple muscle scar and by the extremely chalky white interior.[4] After studying hundreds of available specimens in the collection of the Bureau of Science I am convinced that the commonest Manila oyster has been to the present time without a name. I take pleasure in naming this shell, *O. iredalei* in honor of the conchologist of the Australian Museum, Sidney, Mr. Tom Iredale.

OSTREA MALABONENSIS sp. nov. Plate 2, figs. 3 to 5.

Shell not large, generally small, subtrigonal or irregularly oblong, solid, generally not found in bunches but attached singly to other objects or shells.

Lower valve concave, deep, plaited, plaits rounded, comparatively large, numerous. Upper valve, plain at the middle, but plaited at the margin, sometimes whole upper valve plain throughout.

Shell interior with greenish brown spots. Valve margins not smooth but toothed.

Length, 25 to 45 millimeters.

Type.—No. 14264, Bureau of Science.

Locality.—Malabon, Rizal, Philippines.

This small species is encountered with the preceding species, *O. iredalei,* and is very highly prized on account of its delicious flavor. It can easily be distinguished from *O. plicata* Chemnitz, which is compressed and striped or spotted with purple. *Ostrea malabonensis* is not compressed and is generally yellowish brown. If *O. palmipes* Sowerby can be identified by the exterior of the lower valve presenting the appearance of the webbed foot of a bird, *O. malabonensis* can likewise be identified by the horse's hoof appearance of its lower valve.

[4] Personal communication from W. T. Wells, secretary of the Australian Museum.

ILLUSTRATIONS

[Drawings by Pio Moskaira.]

PLATE 1

FIGS. 1 and 2. *Ostrea iredalei* sp. nov., cotype, × 1; 1, upper or right valve; 2, lower or left valve.

3 and 4. *Ostrea iredalei* sp. nov., type, × 5/8; 3, upper or right valve; 4, lower or left valve.

PLATE 2

FIGS. 1 and 2. *Arca binakayanensis* sp. nov., × 1; 1, right valve; 2, left valve.

3 to 5. *Ostrea malabonensis* sp. nov., × 1; 3, upper or right valve; 4 and 5, lower or left valve.

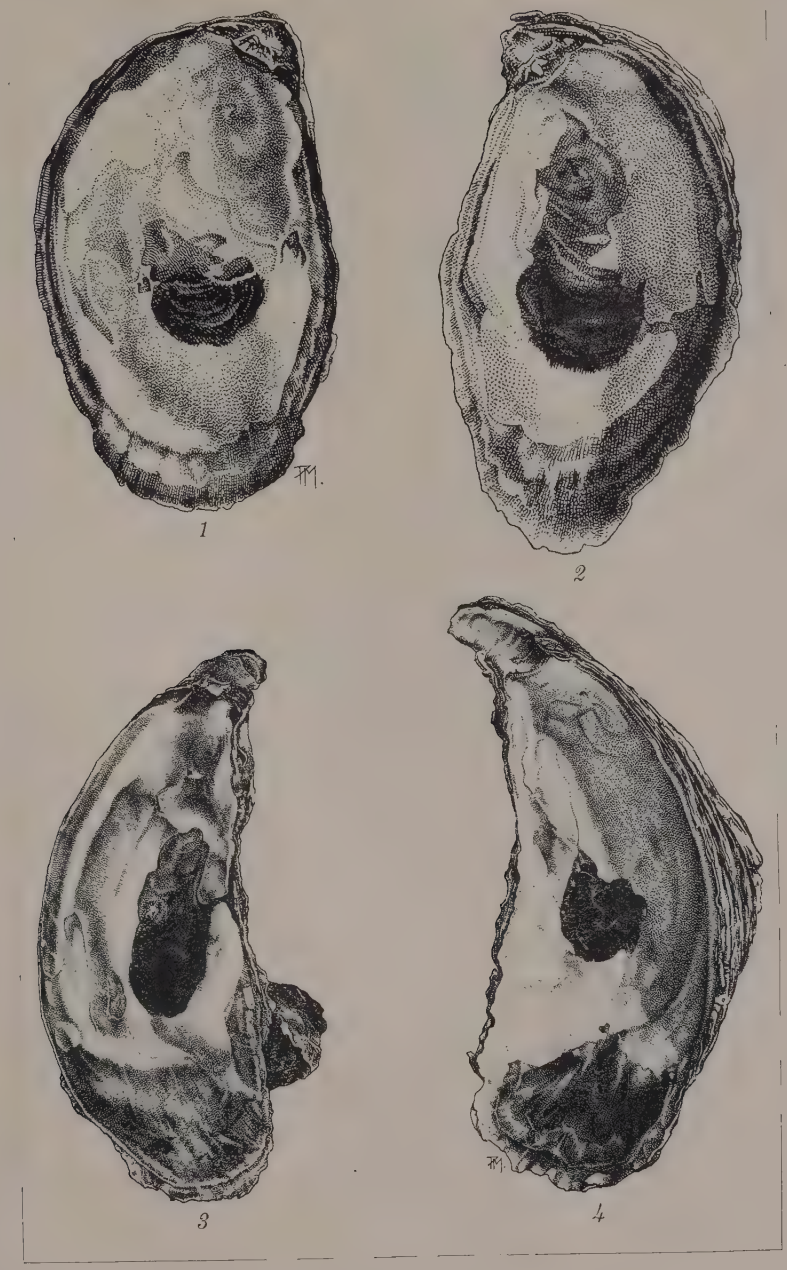
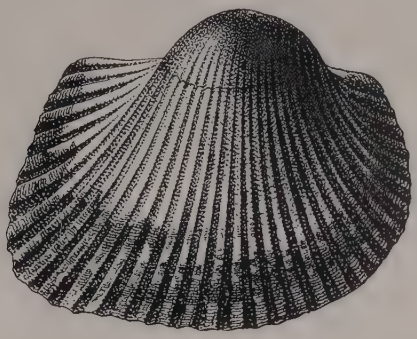


PLATE 1.



1

2

3

4

5

PLATE 2.

EINE NEUE HYDROBIIDE VON DEN PHILIPPINEN

Von Bernhard Rensch

Zoologisches Museum der Universität Berlin

EINE TEXT FIGUR

Herr Dr. L. A. Faustino hatte die Freundlichkeit, mir eine Serie von Hydrobiidenschalen zur Bestimmung zuzusenden, die von Herrn Dr. M. A. Tubangui im Februar, 1932, bei Palo auf Leyte gesammelt waren. Die Untersuchung von Schalen, Deckel und Radula ergab, dass es sich um eine noch unbeschriebene Art handelt, die der ostasiatischen Gattung *Oncomelania* Gredler einzufügen ist.

ONCOMELANIA HYDROBIOPSIS sp. nov.

Diagnose.—Schale (Textabb. 1, *a*) glasig hellbraun, schlank kegelförmig, geritzt, genabelt, Apex stumpf; 6.5 bis 7 gewölbte Umgänge, der letzte davon mehr als die Hälfte der Gehäusehöhe einnehmend; Naht vertieft; Oberfläche fettig glänzend, mit feinen, etwas ungleichmässigen Zuwachsstreifen; Mundöffnung senkrecht, eiförmig, eben zugespitzt; unmittelbar hinter der Mündung eine gelbliche, wulstige Verdickung; Mundungsränder durch dicken Callus verbunden.

Höhe 4.2 bis 5.6 mm; Durchm. 2.5 bis 2.9 mm; Mündungshöhe 2.0 bis 2.2 mm.

Deckel glasig, mit zwei excentrisch gelegenen Windungen (vergl. Textabb. 1, *b*).

Fig. 1. *Oncomelania hydrobiopsis* sp. nov.; *a*, schale; *b*, operculum; *c*, radula.

Mittelzahn der Radula dreizackig und jederseits mit drei hinteren Spitzen an der Basalplatte (typisch für die Gattung *Oncomelania*). Der beiderseits folgende Zahn mit breiter lang ausgezogener Basalplatte und 6 Zacken, von denen die dritte von innen am längsten ist, der darauf folgende Zahn mit 8, der äusserste mit 5 oder 6 Zacken (Textabb. 1, *c*).

Die übrigen bekannten, in Japan, China und auf Formosa beheimateten *Oncomelania*-Arten sind sämtlich grösser als *hydrobiopsis*. Am ähnlichsten ist vielleicht *O. moellendorffi* (Schmacker and O. Boettger) von China, die ebenfalls einen starken Wulst hinter dem Mundsaum hat, aber flachere Umgänge, einen stichförmigen Nabel und viel derbere Skulptur besitzt. Die in der Schalenform ähnliche, aber erheblich grössere und schlankere *Hypsopia nosophora* Robson von Japan (ein Schistosomiasis-Ueberträger), hat einen fünfzackigen Mittelzahn und stärker excentrisch gewundenen Deckel.[1]

Ich verglich auch noch die zahlreichen in der Schalenform ähnlichen, indoaustralischen Schneckenarten, die vorläufig als *Assiminea* oder *Paludinella* bezeichnet werden, deren Radula aber noch nicht bekannt ist. Es stimmt jedoch auch von diesen keine mit der neubeschriebenen Art überein.

[1] Brit. Med. Journ. 1 (1915) 203, pl. fig. 7–9, text fig. 11.

ILLUSTRATION

TEXT FIGUR

FIG. 1. *Oncomelania hydrobiopsis* sp. nov.; *a*, schale; *b*, operculum; *c*, radula.

ENTOMOLOGICA MALAYANA BAKERI: EINIGE UNBESCHRIEBENE RHYNCHITINEN (COLEOPTERA, CURCULIONIDÆ)

25. BEITRAG ZUR KENNTNIS DER CURCULIONIDEN

Von Eduard Voss

Berlin-Charlottenburg, Deutschland

Die vorliegende kleine Abhandlung bringt einige Neubeschreibungen von Rhynchitinen aus der Sammlung des verstorbenen, hochverehrten Forschers Prof. C. F. Baker. Mit Ausnahme der ersten Art gehören alle folgenden dem Subgenus *Involvulus* an.

RHYNCHITES PALLICOLLIS sp. nov.

Kopf mit Augen breiter als lang, ziemlich kräftig und sehr dicht punktiert; Stirn und Scheitel kräftig und breit gefurcht. Augen stark vorgewölbt, länger als die Stirn breit; Schläfen parallelseitig, etwa so lang wie die Stirn breit. Rüssel kürzer als das Halsschild, kräftig, unten gerade, oben stumpfwinklig; basale Hälfte mit Mittelkiel, der sich vorn kurz gabelt. Fühler kurz, vor der Mitte eingelenkt; Schaft- und 1. Geisselglied gleichlang, länger als breit; 2. Glied etwas länger als das 1. Glied; 3. und 5. Glied so lang wie das 1. Glied; 4. und 6. Glied etwas länger als breit; 7. Glied so lang wie breit. Erstes und 2. Glied der Fühlerkeule gleichlang, jedes doppelt so lang wie breit; 3. Glied spindelförmig, fast anderthalbmal so lang wie das 2. Glied. Halsschild breiter als lang, konisch, schwach gerundet; Vorderrand durch eine scharfe Furche abgeschnürt. Punktierung mässig stark und dicht. Schildchen viereckig, hinten dreieckig ausgeschnitten. Flügeldecken so lang wie breit, parallelseitig. Punktstreifen kräftig; Zwischenräume schmaler als die Streifen, fein und dicht runzlig punktiert. Hintertibien auffallend lang und schlank, Mitteltibien kürzer, gleichmässig schwach gebogen.

Färbung rot; Halsschild heller rotgelb. Behaarung kurz, anliegend, wenig erhoben. Länge 3.5 mm.

BORNEO, Sandakan (*Baker, 13666*). In meiner Sammlung. Die Art ist unter das Subgenus *Cartorhynchites* zu stellen.

RHYNCHITES RUFESCENS sp. nov.

Kopf quer, ziemlich fein und dicht punktiert; Stirn mit Eindruck, unpunktiert. Augen kräftig vorgewölbt, länger als die Stirn breit, Schläfen sehr kurz. Rüssel etwas kürzer als das Halsschild, schwach gebogen; ziemlich kräftig, im basalen Drittel oben mit Mittelkiel und je einer seitlichen Furche, im übrigen ziemlich kräftig und dicht längspunktiert. Fühler hinter der Rüsselmitte eingelenkt. Schaftglied etwas kürzer als das 1. Geisselglied; letzteres doppelt so lang wie breit; 2. und 3. Glied wenig kürzer als das 1. Glied; 4. Glied etwa anderthalbmal so lang wie breit. Fünftes und 6. Glied etwas länger als breit; 7. Glied so lang wie breit. Erstes und 2. Glied zusammen etwa so lang wie die Geissel, kräftig, jedes gut anderthalbmal so lang wie breit. Halsschild so lang wie breit; seitlich ziemlich kräftig gerundet, die grösste Breite liegt hinter del Mitte, am Vorderrand schmaler als an der Basis. Punktierung gleichmässig fein und dicht, feiner als diejenige des Kopfes. Schildchen viereckig, fein und sehr dicht punktiert. Flügeldecken fast anderthalbmal so lang wie breit, von den Schultern schwach geradlinig bis über die Mitte hinaus verbreitert, dann in gleichmässigem Bogen zugerundet. Punktstreifen vorn sehr kräftig, hinten viel feiner, der Nahtstreif im basalen Teil breit furchenartig; Zwischenräume vorn schmaler und etwa vom basalen Drittel ab breiter als die Streifen, sehr fein und mässig dicht unregelmässig punktiert. Pygidium fein und sehr dicht punktiert, ebenso die Hinterbrust (besonders im hinteren Teil), mit Seitenteilen. Tibien kräftig, die Mitteltibien am kürzesten, gebogen; Schenkel kräftig.

Färbung rot; Fühlerkeule sowie das letzte Geisselglied schwarz. Behaarung kurz, dicht, geneigt, untermischt mit längeren abstehenden Haaren; auch Abdomen und Tibien abstehend gelb behaart, Mittel- und Hinterbrust sparsamer anliegend behaart. Mittel- und Hinterschenkel aussen mit einer Doppelreihe feiner schwarzer Punkte saumartig besetzt. Länge 3.6 mm.

BORNEO, Sandakan (*Baker, 13954*). In meiner Sammlung.

Von *R. nigriclavatus* m., dem die vorliegende Art am nächsten steht, ist sie durch die sehr dichte Halsschildpunktierung sowie durch den kürzeren Rüssel zu unterscheiden.

RHYNCHITES SUBVIRENS sp. nov.

Weibchen.—Kopf gleichmässig sehr dicht, fast runzlig punktiert. Rüssel fast so lang wie Kopf und Halsschild zusammen, mässig stark gebogen, im basalen Teil mit scharfem Mittelkiel, seitlich desselben matt chagriniert, vorn glänzend, zerstreut punktiert. Stirn mit länglich dreieckigem Eindruck an der Rüsselwurzel. Fühler hinter der Mitte des Rüssels eingelenkt. Schaft- und 1. Geisselglied gleichlang, gut doppelt so lang wie breit; 2. Glied wenig kürzer; 3. bis 5. Glied wiederum etwas kürzer; 6. Glied etwa anderthalbmal so lang wie breit; 7. Glied so lang wie breit. Erstes Glied der Keule wenig länger als breit; 2. Glied kaum so lang wie breit; 3. Glied etwas länger als das 1. Glied. Halsschild wenig länger als breit, seitlich kräftig und gleichmässig gerundet. Skulptur gleichmässig, ziemlich kräftig runzlig; Übergang von Punktierung zur Granulierung, die Erhöhungen sehr dicht chagrinartig punktuliert. Flügeldecken etwa anderthalbmal so lang wie breit, von der Basis bis über die Mitte parallelseitig, dann in gleichmässiger Wölbung zugerundet. Punktstreifen ziemlich fein, linienförmig eingerissen; Zwischenräume viel breiter als die Streifen, mässig stark und sehr dicht, etwas unregelmässig punktiert. Schenkel kräftig; Mittel- und Hintertibien kräftiger als die vorderen, die letzteren leicht gebogen.

Männchen.—Rüssel kürzer, nur so lang wie das Halsschild, weniger gebogen, an der Spitze rot.

Färbung grünmetallisch; Rüssel schwarz; Fühler braun. Behaarung gelblich, kurz, aufgerichtet; auf Mittel- und Hinterbrust lang anliegend, greis, auf dem Abdomen mehr abstehend. Länge, 3 mm.

SINGAPORE (*Baker, 13924; Saunders,* März, 1922). In meiner Sammlung; British Museum (Natural History).

RHYNCHITES SEMIRUGOSUS sp. nov.

Kopf quer, ziemlich fein matt runzlig punktiert. Augen gross, ziemlich kräftig vorgewölbt, etwa doppelt so lang wie die Stirn breit, diese nur wenig schmaler als der Rüssel vor der Basis breit. Rüssel nicht ganz so lang wie Kopf und Halsschild zusammen, schwach gebogen; basaler Teil des Rüssels mit Mittelkiel, von flachen, am Grunde matt chagrinierten Längsfurchen begleitet, vorn längsrunzlig punktiert. Fühler hinter der Rüsselmitte eingelenkt. Schaft- und 1. Geisselglied gleichlang, oval, doppelt so lang wie breit; 2. bis 4. Glied etwas

kürzer als das 1. Glied; die restlichen Glieder wieder etwas kürzer als die vorhergehenden. Fühlerkeulenglieder 1 und 2 kaum länger als breit, kräftig; 3. Glied etwas länger. Halsschild so lang wie breit, seitlich kräftig gerundet, die grösste Breite liegt etwas hinter der Mitte, Vorderrand etwas schmaler als die Basis. Mitte des Halsschilds mit feiner Längsfurche; Punktierung in gleicher Stärke wie der Kopf, sehr dicht runzlig. Flügeldecken etwa ein und ein Viertelmal so lang wie breit, parallelseitig; Punktstreifen sehr kräftig, hinten etwas feiner; Zwischenräume vorn schmaler, hinten breiter als die Streifen, fein und sehr dicht unregelmässig punktiert. Pygidium im basalen Teil dichter und hinten etwas weniger gedrängt punktiert. Vordertibien schlank und gerade, Mittel- und Hintertibien kräftiger und gedrungener, die Mitteltibien an der Spitze innen mit kurzem Fortsatz.

Färbung schwarz, Kopf und Halsschild mit leichtem Erzschein, Unterseite mit blauem Schein. Behaarung sehr kurz, geneigt, untermischt mit wenigen kurzen, abstehenden Härchen. Schildchen dicht anliegend greis behaart. Länge 2.5 mm.

MINDANAO, ZAMBOANGA (*Baker, 24394*). In meiner Sammlung.

Dem *R. furvus* m. nahestehend; während jedoch bei dieser Art auch die Flügeldecken matt runzlig punktiert sind, trifft dies auf die vorliegende Art nicht zu: sie sind glänzend und nur einfach punktiert.

RHYNCHITES MOESTUS sp. nov.

Kopf fein und dicht punktiert; auf der Stirn mit tiefer, vorn geöffneter Furche. Augen anderthalbmal so lang wie die Stirn breit, mässig stark vorgewölbt; Kopf über den Augen breiter als der Vorderrand des Halsschilds. Rüssel so lang wie Kopf und Halsschild zusammen, mässig stark gebogen, auf der basalen Hälfte mit feinem Mittelkiel, vorn kräftig und dicht punktiert. Fühler wenig hinter der Rüsselmitte eingelenkt. Schaft- und 1. Geisselglied gleichlang, länglich oval, doppelt so lang wie breit; 2. bis 4. Glied schwächer, kaum kürzer; 5. Glied erheblich kürzer; 6. Glied noch anderthalbmal so lang wie breit; 7. Glied so lang wie breit. Erstes Glied der Fühlerkeule so lang wie breit; 2. Glied breiter als lang; 3. Glied wenig länger als das erste. Halsschild so lang wie breit, schwach konisch, seitlich kaum gerundet; Punktierung mässig stark, sehr dicht runzlig. Flügeldecken fast anderthalbmal so lang wie breit, von den Schultern ab kurz parallelseitig, dann mässig stark gerundet

verbreitert. Punktstreifen kräftig; Zwischenräume schräg nach innen abfallend, nach aussen scharfkantig, unregelmässig, dicht verlaufen punktiert. Pygidium wenig deutlich punktiert. Vordertibien schlank, Mittel- und Hintertibien kürz und breit.

Färbung braunschwarz. Behaarung kurz abstehend, mässig dicht. Länge 2.8 mm.

LUZON, Mount Maquiling (*Baker*). In meiner Sammlung.

Unter der grossen Zahl verwandter Arten mit runzlig punktiertem Halsschild steht die vorliegende Art dem *R. cinnamomi* m. von Java sehr nahe.

RHYNCHITES PARVUS sp. nov.

Kopf quer, mässig stark und sehr dicht, besonders im basalen Teil runzlig punktiert. Stirn nur halb so breit wie der Rüssel an der Basis. Augen gross, ziemlich kräftig vorgewölbt, etwa dreimal so lang wie die Stirn breit. Schläfen sehr kurz. Rüssel wenig länger als das Halsschild, schwach gebogen. Basis mit Doppelfurche und Mittelkiel, der sich vor der Fühlereinlenkung gabelt und hinter derselben wieder vereinigt, sich dann nach vorn keilförmig verbreiternd. Fühler wenig hinter der Rüsselmitte eingelenkt. Schaft- und 1. Geisselglied gleichlang, fast doppelt so lang wie breit; 2. Glied wenig kürzer; 3. bis 6. Glied etwas kürzer als das 2. Glied; 7. Glied wiederum nur wenig kürzer als die vorhergehenden Glieder. Keule erheblich länger als die Geissel; die Glieder gleichlang, gut anderthalbmal so lang wie breit. Halsschild fast etwas länger als breit, am Vorderrand wenig schmaler als an der Basis, seitlich schwach gerundet. Punktierung ziemlich kräftig runzlig. Schildchen quer, viereckig. Flügeldecken etwa anderthalbmal so lang wie breit, parallelseitig. Punktstreifen sehr kräftig; Zwischenräume schmal, stumpf kielartig, weitläufig einreihig punktiert. Pygidium an der Spitze breit abgestutzt. Hinterschenkel sehr kräftig. Vordertibien schlank, Mittel- und Hintertibien kräftiger und kürzer.

Färbung schwarz. Behaarung ziemlich kurz, etwas geneigt, untermischt mit länger abstehenden Haaren. Während auf der Hinterbrust mit Seitenteilen die Haare mässig dicht, lang anliegend angeordnet sind, sind das Halsschild, das Abdomen und die Beine lang abstehend behaart. Länge 2.5 mm.

MINDANAO, Zamboanga (*Baker*). In meiner Sammlung.

Eine Art, die an der schmalen Stirn unter den verwandten auffällt und leicht kenntlich ist.

RHYNCHITES SIBUYANENSIS sp. nov.

Weibchen.—Kopf quer, fein und sehr dicht, teilweise runzlig verlaufen punktiert. Augen ziemlich kräftig vorgewölbt, ihr Längsdurchmesser grösser als die Stirn breit und diese etwas breiter als der Rüssel an der Basis dick. Schläfen kurz. Rüssel etwas länger als Kopf und Halsschild zusammen, wenig gebogen, von der Basis schwach zur Mitte verschmälert, zur Spitze etwas mehr verbreitert; im basalen Teil mit feinem Mittelkiel, begleitet von je einer Punktfurche; vorn glänzend, vereinzelt punktiert. Fühler etwas hinter der Mitte eingelenkt. Schaft- und 1. bis 4. Geisselglied gleichlang, das Schaft- und 1. Geisselglied jedoch etwas kräftiger, zusammen länger als der Rüssel an der Fühlereinlenkung dick; 5. bis 7. Glied etwas kürzer. Erstes und 2. Glied der Keule fast anderthalbmal so lang wie breit; 3. Glied etwas länger. Halsschild etwas länger als breit, schwach konisch und leicht gerundet nach vorn verschmälert, fein und sehr dicht runzlig punktiert. Flügeldecken gut anderthalbmal so lang wie breit, parallelseitig. Punktstreifen ziemlich kräftig; Zwischenräume breiter als die Streifen, leicht gewölbt, fein und dicht, etwas unregelmässig punktiert. Pygidium wenig vorstehend. Vordertibien schlank, Mittel- und Hintertibien gedrungen, aussen mit einer fein gekerbten Leiste.

Färbung schwarz; Abdomen, Fühlergeissel, Hüften und Beine (mit Ausnahme der angedunkelten Spitzenpartie der Schenkel) mehr oder weniger rot. Grundbehaarung kurz, aufgerichtet, untermischt mit länger aufstehenden Haaren. Mittel- und Hinterbrust mit Seitenteilen fein und dicht anliegend behaart. Länge 3.2 bis 3.5 mm.

INSEL SIBUYAN (*Baker, 21140, 21144*). In meiner Sammlung; United States National Museum.

Beim Männchen ist der Rüssel wenig länger als das Halsschild.

RHYNCHITES JUVENILIS sp. nov.

Kopf quer, sehr fein vereinzelt punktiert. Augen so lang wie die Stirn breit, ziemlich kräftig vorgewölbt; Schläfen kurz. Stirn etwa anderthalbmal so breit wie der Rüssel an der Fühlereinlenkungsstelle dick. Rüssel erheblich länger als Kopf und Halsschild zusammen, schlank, von der Basis zur Fühlereinlenkung konisch verschmälert; im ganzen gleichmässig schwach gebogen; glänzend und kaum sichtbar punktiert, im basalen Teil mit kurzem Mittelkiel und je einer Begleitfurche. Fühler im basalen Fünftel bis Sechstel der Rüssels eingelenkt, das ist um

etwas mehr als Schaftgliedlänge von der Rüsselwurzel entfernt. Schaftglied gestreckt, so lang wie der Rüssel an der Fühlereinlenkungsstelle dick; 1. Geisselglied länglich oval, etwas kürzer als das Schaftglied; 2. Glied so lang wie das Schaftglied; 3. bis 4. Glied erheblich länger, doch nicht ganz so lang wie das Schaft- und 1. Geisselglied zusammen; 5. und 6. Glied noch etwas länger als das Schaftglied; 7. Glied noch doppelt so lang wie breit. Erstes Glied der Keule fast dreimal so lang wie breit; 2. Glied wenig kürzer; 3. Glied so lang wie das 1. Glied, spindelförmig. Halsschild so lang wie breit, seitlich gleichmässig schwach gerundet, am Vorderrand kaum schmaler als an der Basis, vor demselben schwach eingeschnürt; Mittelfurche fein. Punktierung ziemlich fein und wenig dicht. Schildchen quer, viereckig, mit schwachem Grübchen vor der Spitze. Flügeldecken doppelt so lang wie breit, parallelseitig. Punktstreifen kräftig; Zwischenräume so breit wie die Streifen, gewölbt, ziemlich fein, entfernt stehend einreihig punktiert. Pygidium im basalen Teil fein und weitläufig, hinten kräftiger und dichter punktiert. Abdomen sehr fein und zerstreut punktiert. Tibien gerade, mässig schlank, die Hintertibien kräftiger, alle mit schwach gezähntem Aussenkiel. Der verkürzte vorletzte Punktstreif vereinigt sich erst in der Höhe des 1. Abdominalsegments mit dem Randstreif.

Färbung schwarz; Rüssel, Fühler (mit Ausnahme der Keule und der zwei letzten Geisselglieder), Beine und grösstenteils das Abdomen rot; Flügeldecken blau. Behaarung greis, auf den Zwischenräumen der Flügeldecken einreihig gereiht untermischt mit einzelnen abstehenden Härchen; auf dem Halsschild wirr, teilweise mehr abstehend; auf dem Abdomen sparsam, abstehend, an den Seiten der Mittel- und Hinterbrust mit Seitenteilen dicht anliegend; Beine lang abstehend behaart. Länge 3.5 mm.

INSEL BASILAN (*Baker*). Ein Exemplar in meiner Sammlung.

Eine in jeder Hinsicht leicht kenntliche Art, die ihren nächsten Verwandten eigenartigerweise in Westafrika hat.

RHYNCHITES MODESTUS sp. nov.

Kopf mit Augen breiter als lang, ziemlich kräftig und sehr dicht punktiert; Augen gross, mässig stark vorgewölbt, viel länger als die Stirn breit und diese etwas schmaler als der Rüssel vor der Basis dick. Schläfen schwach konisch. Rüssel so lang wie das Halsschild, gleichmässig kräftig gebogen. Basalhälfte mit Mittelkiel, seitlich desselben flach gefurcht und

am Grunde dicht punktiert, vorn kräftig und sehr dicht punktiert. Fühler mittenständig. Schaftglied oval, länger als breit; 1. Geisselglied anderthalbmal so lang wie das Schaftglied, länglich oval; 2. bis 4. Glied länger als das 1. Glied; die restlichen Glieder etwa so lang wie das Schaftglied. Erstes und 2. Glied der Fühlerkeule fast doppelt so lang wie breit; 3. Glied breiter als lang, Endglied konisch zugespitzt. Halsschild so lang wie breit, konisch, seitlich leicht gerundet, am Vorderrand viel schmaler als an der Basis, fein und sehr dicht punktiert. Flügeldecken etwa ein und ein Drittelmal so lang wie breit; bis zur Mitte parallelseitig, dann gerundet verschmälert. Punktstreifen mässig kräftig, hinten etwas feiner als im basalen Teil; Zwischenräume fein und sehr dicht unregelmässig punktiert. Abdomen sehr fein und weitläufig punktiert, Pygidium dagegen kräftiger und dicht. Hinterschenkel kräftig; Vordertibien schlank und gerade, Mitteltibien kräftiger und gedrungener.

Färbung schwarz; Flügeldecken und Unterseite mit leichtem bläulichen Schein. Grundbehaarung ziemlich kurz, wenig geneigt, gelblich, untermischt mit einzelnen, länger abstehenden Haaren. Mittel- und Hinterbrust mit Seitenteilen anliegend, Abdomen mehr abstehend behaart. Länge 4 mm.

SINGAPORE (*Baker, 13923*). In meiner Sammlung.

Die Art steht dem *R. liveus* m. von Vorder-Indien am nächsten, die Fühler sind jedoch viel schlanker, die Zwischenräume sind feiner punktiert, die Grundbehaarung ist kürzer, auch ist die Färbung des Tieres dunkler.

RHYNCHITES FIGURATUS sp. nov.

Kopf breiter als lang, kräftig und dicht punktiert. Augen kräftig vorgewölbt, länger als die Stirn breit, Schläfen sehr kurz. Rüssel ziemlich kräftig, so lang wie Kopf und Halsschild zusammen, kräftig gebogen; oben im basalen Drittel mit Mittelfurche und je einer Begleitfurche, im ganzen kräftig und sehr dicht längsrunzlig punktiert. Fühler zwischen der Mitte und dem basalen Drittel eingelenkt. Schaft- und 1. Geisselglied gleichlang, oval, nicht ganz doppelt so lang wie breit; 2. und 3. Glied etwas länger. Halsschild breiter als lang, Vorderrand wenig schmaler als die Basis, vor demselben leicht eingeschnürt, seitlich schwach gerundet, die grösste Breite liegt etwas hinter der Mitte. Punktierung fein, sehr dicht querrunzlig. Schildchen quer viereckig, fein und dicht punktiert. Flügeldecken etwa anderthalbmal so lang wie breit, parallelseitig. Punkt-

streifen kräftig, hinten etwas feiner; 1. bis 3. Zwischenräume breiter als die Streifen, die seitlichen schmaler, sehr fein und dicht unregelmässig punktiert. Vordertibien schlank, die hinteren kräftig, keilartig zur Spitze verbreitert.

Färbung rotgelb; Seiten des Halsschilds und ein Mittelband, Schildchen, Naht und Seiten der Flügeldecken, vor der Mitte derselben vom 4. Zwischenraum bis zur Naht mit einem + ~ — förmigen Querband und hinter der Mitte mit einem ebenfalls geschwungenen querband, welches durch den 3. Zwischenraum unterbrochen wird, Vorder-, Mittel-, Hinterbrust, die Schenkel mit Ausnahme der Basis, Spitze der Tibien und Tarsen dunkler gebräunt. Behaarung auf den Zwischenräumen der Flügeldecken quer gelagert, greis, anliegend, sonst länger abstehend. Länge 3.2 mm.

MINDANAO, Butuan (*Baker, 4430*); Surigao (*Boettcher* Juli, 1916). In meiner Sammlung, Mus. Berlin (coll. Moser).

Die durch die greise, dichte Behaarung der Zwischenräume verstärkte Zeichnung der Flügeldecken macht diese Art unter den bisher bekannten leicht kenntlich.

RHYNCHITES AZURESCENS sp. nov.

Eine Art, die dem *R. helleri* m. sehr nahe steht und mit diesem leicht verwechselt werden könnte, wenn nicht einige Gegensätze ziemlich scharf ausgeprägt wären: Der auffälligste Unterschied liegt in anderer Kopfform, so sind die Augen wesentlich kleiner und nicht viel länger als die Stirn breit. Der Rüssel, der bei *helleri* in der basalen Hälfte parallelseitig ist, läuft bei unserer Art konisch verjüngt zur Mitte zu. Die beiden ersten Glieder der Fühlerkeule sind etwas schlanker und länger und die Behaarung ist wesentlich sparsamer, sodass die Art tiefer blau gefärbt erscheint. Auch in der Punktierung der Decken liegen geringe Unterscheide.

MINDANAO, Surigao (*Baker, 17108, 17109*). In meiner Sammlung; United States National Museum.

MELASIDÆ ET ELATERIDÆ NOUVEAUX DES ILES PHILIPPINES

Par E. Fleutiaux

Nogent-sur-Marne, Seine, France

MELASIDÆ

FORNAX HADDENI sp. nov.

Longueur 7.5 mm. Allongé, atténué; brun obscur; pubescence jaune. Tête convexe, densément ponctuée; crête interoculaire interrompue au milieu; épistome notablement rétréci en arrière, moins large à la base que l'espace surantennaire. Antennes brunes, filiformes, dépassant légèrement la base du prothorax; 2e article très petit; 3e long; 4e un peu plus court. Pronotum aussi long que large à la base, subgraduellement rétréci en avant, peu convexe, densément ponctué. Elytres atténués dès la base, terminés en pointe, finement pointillés, très légèrement substriés. Dessous de même couleur, finement et densément ponctué. Sillons antennaires étroits, nettement rebordés en dedans, lisses et brillants. Pointe prosternale arrondie au sommet. Abdomen faiblement comprimé; dernier arceau ventral en pointe obtuse. Pattes brunes.

Luzon, Laguna, Pangil, mai (*F. C. Hadden*).

Voisin de *F. dircæoides* Fleutiaux. Pronotum graduellement rétréci de la base au sommet; élytres atténués dès la base. Diffère de *F. subacuminatus* Bonvouloir par le pronotum graduellement rétréci, par la ponctuation des élytres plus légère, par le dernier arceau ventral en pointe obtuse.

FORNAX SEMINIGER Fleutiaux var. NIGRICEPS nov.

Fornax seminiger Fleutiaux, Ann. Soc. Ent. France (1926) 46, 48. (Subgen. *Spinifornax* Fleutiaux.)

Tête noire.

Luzon, Laguna, Pangil, avril (*F. C. Hadden*).

ELATERIDÆ

MELANOXANTHUS HADDENI sp. nov.

Longueur 8 mm. Allongé, peu convexe; noir, pronotum rouge sur presque toute sa surface en arrière; élytres ornés chacun

d'une large bande jaune pâle médiane à la base, prolongée jusqu'à la moitié et d'une tache ronde de même couleur avant l'extrémité; pubescence peu apparente, de la couleur du fond. Tête peu convexe, arrondie en avant, densément ponctuée. Antennes noires, comprimées, ne dépassant pas la base du prothorax. Pronotum brillant, plus long que large, parallèle, brusquement arrondi aux angles antérieurs, peu convexe; ponctuation très fine et peu serrée; angles postérieurs aigus, non divergents, bicarénés. Elytres subparallèles, rétrécis dans le dernier tiers, tronqués au sommet, peu convexes, densément ponctués, striés-ponctués. Dessous finement et densément ponctué; pubescence jaune légère; propectus jaune clair; métasternum et abdomen noirs. Pattes jaune clair.

LUZON, Laguna, Mont Maquiling, mai (*F. C. Hadden*).

Ressemble à *M. exclamationis* Candèze; moins convexe, plus brillant; taches des élytres jaune pàle; sommet des élytres tronqué; pourtour du pronotum en avant el latéralement noir; dessous de l'arrière-corps noir.

MELANOXANTHUS FINITIMUS sp. nov.

Longueur 6 mm. Allongé, subparallèle, peu convexe; dessus jaune, tête écusson et sommet des élytres noirs, brillant; pubescence fine, peu apparente, de la couleur du fond. Tête convexe, ponctuation peu serrée. Antennes noires, comprimées et faiblement élargies vers le bout; 3e article semblable et presque aussi long que le suivant. Pronotum un peu plus long que large, paralléle, arrondi aux angles antérieurs; ponctuation moins forte que sur la tête, peu serrée; angles postérieurs aigus, non divergents, brièvement carénés. Elytres ponctués-striés; interstries plans et finement pointillés. Propectus jaune, pointe prosternale noire; reste du dessous noir, très finement ponctué. Pattes noirâtres; trochanters jaunes.

LUZON, Laguna, Mont Maquiling, janvier (*F. C. Hadden*).

Ressemble à *M. dimidiatipennis* Candèze; tête non carénée au milieu; antennes entièrement noires; pronotum paralléle; élytres moins rugueux, noirs seulement au sommet sur le cinquième postérieur; dessous de l'arrière–corps noir; pattes noirâtres.

MELANOXANTHUS LATERALIS sp. nov.

Longueur 4 mm. Allongé, noir, angles du pronotum jaune pâle, élytres testacés avec la suture noire; pubescence jaune clairsemée. Tête convexe; ponctuation assez forte, irrégulièrement espacée. Antennes brunes, plus claires à la base, ne dépassant pas la base du prothorax. Pronotum plus long que large,

faiblement rétréci en avant, convexe; ponctuation assez large, peu profonde, irrégulièrement espacée; angles postérieurs grands, aigus, insensiblement divergents, carénés. Elytres convexes, arrondis latéralement et rétrécis en arrière, entiers au sommet, fortement ponctués-striés; ponctuation des interstries espacée. Dessous et pattes noirs.

LUZON, Baguio, 5,000 pieds, mars (*F. C. Hadden*).

Voisin de *M. fusus* Candèze; plus allongé; élytres de la même largeur que le pronotum, moins fortement ponctués-striés; bords externes largement testacés; pattes noires.

MEGAPENTHES CINCTUS sp. nov.

Longueur 9 mm. Oblong, assez large, peu convexe; noir avec la base du pronotum et le pourtour des élytres jaune brillant; pubescence obscure, rousse sur les parties jaunes. Tête peu convexe, densément ponctuée. Antennes courtes, ferrugineuses; 3e article de même forme, mais notablement moins long que le suivant. Pronotum un peu plus long que large, parallèle, arrondi aux angles antérieurs, convexe, brusquement déclive à la base, impressionné le long du bord postérieur, très légèrement sillonné au milieu en arrière, assez densément ponctué; angles postérieurs courts, non divergents, unicarénés. Elytres arrondis et rétrécis seulement dans le dernier tiers, légèrement ponctués-striés, presque indistinctement au sommet; interstries plans, finement et espacément pointillés; bande jaune entourant les élytres assez large occupant la base, rétrécie sur le bord externe au delà de la moitié. Dessous noir, bord latéral des propleures jaune; pubescence brune. Pattes testacées.

LUZON, Laguna, Mont Maquiling, 400 pieds, juin (*F. C. Hadden*).

Voisin de *M. curtus* Candèze; front non caréné au milieu; élytres de même largeur que le pronotum, stries plus légères.

MONOCREPIDIUS HADDENI sp. nov.

Longueur 8.5 mm. Oblong, ellïpsoidal, peu convexe; noir peu brillant; pubescence fauve légère, plus sombre sur la tête et le pronotum. Tête plate, impressionnée au milieu en arrière, densément ponctuée; palpes testacé pâle. Antennes fines, n'atteignant pas la base du prothorax, testacées, noirâtres vers le milieu. Pronotum plus long que large, arrondi sur les côtés, peu rétréci en avant, brusquement déclive à la base, faiblement et brièvement sillonné en arrière, finement et densément ponctué; angles postérieurs courts, non divergents, carénés. Elytres arrondis latéralement et graduellement atténués, fortement striés-ponc-

tués; interstries plans sur le dos, convexes sur les côtés, densément ponctués. Dessous noir; pubescence fauve, finement et densément ponctuée, surtout sur l'abdomen. Hanches postérieures anguleuses. Pattes testacé pâle.

LUZON, Laguna (*F. C. Hadden*).

De même forme que le *M. horistonatus* Candèze; de couleur noire.

NEODIPLOCONUS NIGRIPES sp. nov.

Longueur 11 mm. Allongé, atténué en avant et en arrière; noir, pronotum rouge sanguin, sauf sur le bord antérieur et à l'extrémité des angles postérieurs; pubescence grise. Tête peu convexe, déprimée en avant; bord antérieur arrondi et rebordé; ponctuation peu serrée. Antennes noires, dépassant la base du prothorax; 3e article légèrement plus long que le 2e; 4e égal aux deux précédents réunis. Pronotum plus long que large, graduellement et notablement rétréci en avant, peu convexe, sillonné au milieu en arrière; ponctuation plus apparente en avant et sur les côtés, extrêmement fine et très écartée sur le dos, nulle à la base; angles postérieurs aigus, divergents, bicarénés. Elytres graduellement rétrécis, conjointement arrondis au sommet, peu convexes, très légèrement ponctués-striés, presque lisses. Dessous et pattes noires.

LUZON, Mountain Province, Mont Data, 5,000 pieds, mars; Baguio, 5,000 pieds, mars; Laguna, Mont Maquiling, mai (*F. C. Hadden*).

Moins brillant que *N. haddeni* Fleutiaux; ponctuation de la tête moins forte; pronotum graduellement rétréci, non arrondi sur les côtés; angles postérieurs divergents; élytres presque lisses; dessous et pattes noires.

NEODIPLOCONUS COXALIS sp. nov.

Longueur 9.5 mm. Allongé, parallèle; noir brillant; pubescence jaune peu abondante. Tête déprimée, arrondie et rebordée en avant; ponctuation forte, peu profonde, rugueuse. Antennes brunes, courtes. Pronotum plus long que large, parallèle, arrondi aux angles antérieurs, brièvement sillonné au milieu en arrière et à la base; ponctuation assez forte, peu serrée, moins marquée en arrière; angles postérieurs légèrement divergents, aigus bicarénés. Elytres de la même largeur que le pronotum, parallèles, arrondis dans le dernier quart, entiers au sommet; ponctués-striés, interstries plans et finement pointillés. Dessous ferrugineux, propleures noirs. Propectus assez fortement ponc-

tué; arrière-corps plus légèrement. Hanches postérieures graduellement rétrécies en dehors. Pattes ferrugineuses.

LUZON, Laguna, Mont Maquiling, 400 pieds, juin; Laguna, Pangil, mai; Tayabas, Quezon Park, mai (*F. C. Hadden*).

Voisin de *N. cantharus* Candèze; plus étroit, plus parallèle; noir; ponctuation plus distincte; hanches postérieures non anguleuses.

NEODIPLOCONUS FUSCUS sp. nov.

Longueur 10.5 mm. Allongé, atténué, peu convexe; noir; pubescence jaune peu abondante. Tête convexe, arrondie en avant; ponctuation forte, peu profonde peu serrée. Antennes brunes, ne dépassant pas la base du prothorax. Pronotum plus long que large, sinué sur les côtés, rétréci en avant, impressionné à la base; ponctuation assez forte, peu serrée, effacée à la base; angles postérieurs aigus, non divergents, bicarénés. Elytres de même largeur que le pronotum, arrondis latéralement et rétrécis en arrière, entiers au sommet, légèrement ponctués-striés; interstries pointillés. Dessous ferrugineux. Pattes plus claires.

LUZON, Laguna, Mont Maquiling, 400 pieds, juin (*F. C. Hadden*).

Moins parallele que *N. coxalis* m.; antennes plus longues; ponctuation de la tête et du pronotum moins forte; interstries des élytres légèrement convexes.

NEUE BRENTHIDÆ UND LYCIDÆ VON DEN PHILIPPINEN

Von R. Kleine

Stettin, Deutschland

EINE TAFEL

Genus MACROPAREIA novum

Von robuster Gestalt. Kopf länger als breit, durch das mit demselben verbundene Meta- und Mesorostrum stark verlängert erscheinend; Hinterrand tief, dreieckig eingebuchtet und in eine tiefe Mittelfurche verlängert, die sich auf dem Metarostrum noch mehr vertieft; Oberseite abgeplattet, Wangen gross, platt; Unterseite platt mit einer bis zum Rüssel durchgehenden Mittelfurche; Augen nach vorn gerückt, mittelgross. Metarostrum mit dem Kopf in einer Ebene liegend; Mesorostrum unentwickelt, schmal, tief gefurcht; Prorostrum kurz, am Vorderrand so breit wie der Kopf, daselbst tief eingebuchtet; Mandibeln kräftig. Fühler nach vorn in tiefen Gruben eingesenkt, robust, 2. bis 8. Glied breiter als lang, basale Glieder mehr rundlich, die vorderen mit kantigem Vorderrand, 9. und 10. nicht breiter als das 8., aber länger und fast quadratisch, 11. so lang wie das 9. und 10. zusammen. Prothorax gegen den Hals stark verengt, ungefurcht. Zweite Rippe auf den Elytren in der Mitte weit unterbrochen, die übrigen Rippen mehr oder weniger breit, platt, zum Teil breiter als die Furchen. Beine robust, Vorderschiene mit Zahnartigem Haarbüschel, Schienen der Hinterbeine im Verhältnis zur Länge sehr breit, Metatarsus länger als das 2. und 3. Glied zusammen, seitlich stark zusammengepresst.

Typus der Gattung: *M. schultzei* sp. nov.

In meiner Bestimmungstabelle der Brenthidæ komme ich zur Gattung *Orthopareia* Kleine, die auch nur auf den Philippinen vorkommt. Eine gewisse Verwandtschaft damit ist sicher vorhanden. So ist beiden Gattungen die unterbrochene 2. Rippe

auf den Elytren gemeinsam, ausserdem ist der Rüssel von ähnlicher Gestalt. Die Unterschiede sind folgende:

Orthopareia.	*Macropareia.*
Kopf breiter als lang, Hinterrand gerade, gewölbt, ungefurcht.	Kopf länger als breit, durch die Tiefe über den ganzen Kopf reichende Furche fast in zwei Teile zerlegt.
Metarostrum schmaler als der Kopf, Mesorostrum erweitert.	Metarostrum von Kopfbreite, Mesorostrum ganz schmal.
Fühler lang, Glieder quadratisch oder länger als breit.	Fühler kurz, mit Ausnahme des 11. sind alle Glieder breiter als lang.
Prothorax gegen den Hals nicht verengt, tief gefurcht.	Prothorax stark verengt, ungefurcht.

MACROPAREIA SCHULTZEI sp. nov.

Hell schokoladebraun, Halsschildrand, Vorderrand der Fühlerglieder, Schenkel und Schienen an Basis und Spitze schwarz, am ganzen Körper hochglänzend. Kopf einzeln punktiert, Rüssel, namentlich das Prorostrum, sehr dicht und tief punktiert. Fühler auffallend schwach behaart, selbst das 9. bis 11. Glied sind nur mit ganz geringem Haarwuchs bedeckt. Prothorax, Metasternum, Abdomen, und die Beine mit derselben Skulptur versehen.

Länge, 13 mm., Breite, (Prot.) 1.75 mm.

PANAY, Antique, Culasi (*W. Schultze*).

Typus in dessen Sammlung.

LYCIDÆ

CALOCHROMUS LUZONICUS sp. nov.

Unterseite des Körpers, Kopf, Beine und Fühler blauschwarz, mit Ausnahme der Fühler stark glänzend; Prothorax, Schildchen und Elytren mit Ausnahme eines grauschwarzen keilförmigen Fleckes im Spitzenteil schmutzig bleichgelb, die dunkle Partie mit undeutlichen hellen Rippen, die auch ganz fehlen können. Kopf dicht punktiert und behaart mit deutlicher Mittelfurche, Mandibulartaster mit beilförmigem Endglied. Fühler schlank, 1. bis 4. Glied Abb. 4, die folgenden von gleicher Länge, nach und nach schmaler werdend. Prothorax Abb. 5, Mittelfurche im vorderen Drittel fehlend, sonst sehr tief. Schildchen lippenförmig. Elytren mit sehr kurzer Behaarung, sodass die Rippen, auch die sekundären, deutlich erkennbar sind. Schenkel ungedornt.

Länge, 13 bis 14 mm., Breite, (Hum.) 3 mm.

LUZON, Benguet, Baguio, 2 Männchen.

Typus in der Sammlung Schultze, Cotype in meiner Sammlung.

Die Art ist durch die Ausfärbung mit keiner anderen in der ganzen Gattung zu verwechseln. Auf den Philippinen ist die helle Elytrenfarbe namentlich in der Gattung *Plateros* häufig, bei *Calochromus* aber bisher gänzlich unbekannt. Ausserdem is die Anlage der Elytrenverdunklung ganz apart. Bemerkenswert ist auch das Zusammentreffen der stahlblauen Körperunterseite mit der schmutziggelben Oberseite.

LIBNETIS SPINICORNIS sp. nov.

Gleicht in Ausfärbung und Habitus *decolor* Kleine durchaus. Durch die an der Spitze innenseits gedornten Fühlerglieder sicher und leicht zu unterscheiden.

Länge, 4 mm., Breite, (Hum.) 1 mm. circa.

MINDANAO, Bukidnon, Tangkulan (*C. F. Baker*), 1 Männchen.

Typus in meiner Sammlung.

PLATEROS ZONATUS sp. nov.

Schwarzbraun, Prothorax an den Seitenrändern breiter, am Vorderrand nur ganz schmal und die Elytren in der vorderen Hälfte bleichgelb. Stirn flach, rundlich vertieft, Fühlerbeulen schwach entwickelt, glänzend. Fühler robust, 1. bis 4. Glied Abb. 8, die folgenden von gleicher Länge, aber nach und nach schmaler werdend, ohne Zähnung; Behaarung dicht und kräftig, ausser der Unterbehaarung mit einzelnen langen abstehenden Haaren besetzt. Prothorax etwas breiter als hoch, Hinterecken vorgezogen. (Abb. 9). Vorder- und Seitenrand erhöht, Randpunktierung kräftig, Behaarung sehr gering. Schildchen zungenförmig, am Hinterrand kaum eingebuchtet. Elytren mit kurzer dichter Behaarung, die nur die Primärrippen erkennen lässt. Die beiden Farbenkomplexe sind scharflinig getrennt. Penis Abb. 10.

Länge, 8 mm., Breite, (Hum.) 1.5 mm. circa.

LUZON, Benguet, Santo Tomas. Männchen und Weibchen.

Holotypus in Sammlung Schultze; Allotypus in meiner Sammlung.

Es handelt sich um eine grosse Art aus der Verwandtschaft von *cuneatus* und *ponderosus*. Die Trennung ist aber durch den Penis sehr leicht und sicher, da das Organ *fulgidus* ähnlich ist, nicht aber den genannten Arten. Mit *fulgidus* besteht hingegen keinerlei Uebereinstimmung, schon durch die Ausfärbung nicht.

PLATEROS PUDENS sp. nov.

Abdomen schwarzbraun, Brust gelb, Beine braun mit hellgelber Schenkelbasis, Kopf orangegelb, Fühler schwarz, die ersten beiden Glieder gelbbraun, Prothorax, Schildchen und Elytren strohgelb. Die Stirn anderthalbmal so breit wie ein Augenhalbmesser, über den flachen Fühlerbeulen mit zwei punktartigen Vertiefungen, Behaarung sehr gering. Erstes bis sechstes Fühlerglied Abb. 12, nach vorn nehmen die Glieder an Breite und Länge ab, 9. und 10. Glied ohne Zähnung, 11. länger als das 10., kräftig behaart. Prothorax Abb. 13, breiter als lang, Vorderecken stumpf, Seiten hinter der Mitte nach innen gebogen, Hinterecken deutlich vorgezogen, alle Ränder erhöht, Randpunktierung gross, einzeln, Behaarung schwach. Schildchen zungenförmig, hinten nicht eingekerbt, kurz behaart. Elytren mit sehr deutlichen Rippen und ebensolcher Gitterung, die durch die kurze Behaarung nicht verdeckt wird; Gitterung vier- bis fünfeckig.

Länge, 6.5 mm., Breite, (Hum.) 1.25 mm.

MINDANAO, Zamboanga (*C. F. Baker*), 1 Weibchen.

Typus in meiner Sammlung.

Pudens ist mit *luteolus* Kleine und *generalis* Kleine zu vergleichen. Von ersterer Art unterscheidet sie sich sehr leicht durch den queren Prothorax, von *generalis* durch die hellgefärbte Brust und die zweifarbigen Schenkel.

PLATEROS PAULULUS sp. nov.

Einfarbig schwarz, nur der Prothorax mit schmutzig-orangeroten Seitenrändern. Stirn doppelt so breit wie ein Augenhalbmesser, über den Fühlerbeulen flach eingesenkt, diese mit deutlicher Mittelrinne. Erstes bis fünftes Fühlerglied Abb. 13, nach vorn nehmen die Fühlerglieder an Breite, nicht aber an Länge ab, 11. Glied wenig länger als das 10., Behaarung kurz und einzeln. Prothorax Abb. 14, Vorderecken gerundet, Hinterecken nicht vorgezogen, Seiten fast gerade, Ränder mässig aufgebogen, Randpunktierung kräftig, Behaarung einzeln. Schildchen zungenförmig, nicht eingekerbt. Auf den Elytren sind Rippen und Gitterung zwar nur sehr flach ausgebildet, werden aber durch die sehr kurze und einzelne Behaarung nicht verdeckt. Gitterung vier bis fünfeckig. Penis Abb. 15.

Länge, 6.5 mm., Breite, (Hum.) 1.5 mm.

LUZON, Mt. Banahao, 1 Männchen.

Typus in meiner Sammlung.

Von den in der Ausfärbung sehr ähnlichen *triangulus* Kleine, *simillimus* Kleine, *contrarius* Kleine und *contextus* Kleine durch den gänzlich anders gebauten Penis leicht zu unterscheiden.

PLATEROS EXIGUUS sp. nov.

Abdomen schwarz, Brust gelb, Beine mit Ausnahme der gelben Schenkelbasis schwarz, Kopf und Fühler von derselben Farbe, Prothorax und Schildchen orangegelb, Elytren im vorderen Drittel von derselben Farbe, sonst schwarz. Stirn nur so breit wie ein Augenhalbmesser, über den flachen Fühlerbeulen schwach vertieft. Fühler wie bei *pudens*. Prothorax so breit wie in der Mitte hoch, Vorderecken mehr oder weniger gerundet, Hinterecken spitz vorgezogen, Ränder aufgebogen, Randpunktierung gross, einzeln, Behaarung sehr gering, Abb. 16. Schildchen zungenförmig, Hinterrand fast gerade, Behaarung sehr gering, Elytren mit sehr deutlichen Rippen und gleicher Gitterung, Behaarung sehr gering, die Skulptur nicht verdeckend, Gitterung vorherrschend fünfeckig, seltener viereckig.

Länge, 4 bis 6 mm., Breite, (Hum.) 1 bis 1.25 mm.

MINDANAO, Zamboanga; Insel Basilan (*C. F. Baker*), 3 Männchen.

Typus in meiner Sammlung.

Von allen bisher bekannten Arten besteht die grösste Aehnlichkeit mit *constans* Kleine. Der Penis ist von ähnlicher Gestalt, aber die Fühler sind in beiden Arten ganz verschieden. Während bei *exiguus* das 3. und die folgenden Glieder kräftig gezähnt sind, fehlt die Zähnung bei *constans* vollständig und die Glieder liegen schmal dicht einander an. Die Trennung der beiden Arten ist auch ohne Penisautopsie leicht. Die Identität der einzelnen Stücke war nur durch Penisvergleich möglich.

LEPTOTRICHALUS PERVERSUS sp. nov.

Abdomen, Brust und Beine blau metallisch, glänzend, Kopf und Fühler schwach, Prothorax, Schildchen und das basale Drittel der Elytren hell strohgelb, hintere zwei Drittel schwarzbraun. Kopf über den Fühlerbeulen vertieft, Fühler schlank 8. bis 11. Glied Abb. 19. Prothorax mit stark aufgebogenen Seitenrändern und schwacher Randpunktierung, Areole nur am Hinterrand offen. Schildchen hinten tief eingekerbt. Elytrengitterung vorherrschend quer rechteckig, in der hinteren Hälfte zum Teil ohne deutliche Figuren, Behaarung kurz.

Länge, 17 mm., Breite, (Hum.) 4 mm.

LUZON (*Boettcher*), 1 Weibchen.

Typus in meiner Sammlung.

Die Art unterscheidet sich von allen bisher bekannten sehr leicht durch die Ausfärbung und ist nur mit der nächstfolgenden zu vergleichen.

LEPTOTRICHALUS PLACITUS sp. nov.

Grauschwarz, Prothorax mit mehr oder weniger gelbgrauen Rändern, Schildchen gelbgrau, Elytren im basalen Teil von gleicher Ausfärbung, die ohne scharfen Absatz in die graue Farbe übergeht. Prothorax wie bei der vorigen Art, Ränder weniger scharf aufgebogen. Fühler sehr schlank, 8. bis 11. Glied Abb. 20. Schildchen hinten nicht eingekerbt. Elytrengitterung unscharf, vier- bis fünfeckig.

Länge, 13 mm., Briete, (Hum.) 3 mm.

LUZON, Baguio (*C. F. Baker*), 2 Weibchen.

Typus in meiner Sammlung.

Die Ausfärbung ist der vorigen Art recht ähnlich, ist aber, wie an den vorliegenden Exemplaren zu sehen ist, etwas wechselnd. Auf den Elytren kann die graue Farbe bis zur Basis vordringen, lässt dann aber immer noch die Seitenränder frei. *Placitus* ist viel schlanker als *perversus*, die Fühler sind von ganz anderer Gestalt und das Schildchen ist nicht eingebuchtet.

LEPTOTRICHALUS RELIQUUS sp. nov.

Abdomen graubraun, Brust und Beine gelblich braun, die Schenkel noch weiter aufgehellt, Kopf schwarzbraun, Rüssel und Fühler rotbraun, Prothorax strohgelb mit braunlicher Areole, Schildchen und das basale Fünftel der Elytren strohgelb, allmählich in graubraune Farbe übergehend. Fühler wie bei *perversus*. Areole des Prothorax an beiden Seiten geschlossen, Ränder nur schwach aufgebogen. Schildchen deutlich eingebuchtet. Elytrengitterung namentlich im vorderen Teil unregelmässig Abb. 21.

Länge, 8.5 mm., Breite, (Hum.) 1.75 mm. circa.

LUZON (*Boettcher*), 1 Männchen.

Typus in meiner Sammlung.

Die Art unterscheidet sich von den beiden vorhergehenden abgesehen von der Ausfärbung vor allen Dingen durch die ganz verschiedene Elytrengitterung. Auch an den Teilen des Organes, wo die Skulptur nicht unterbrochen ist, sind die Gitterungsfiguren nicht quadratisch oder regular fünfeckig, sondern immer auffallend lang.

LEPTOTRICHALUS INCERTUS sp. nov.

Schwarzbraun, nur die Elytren im basalen Viertel hellgelb. Fühler sehr schlank, ähnlich wie *placitus*. Prothorax mit auffallend nach aussen vorgezogenen spitzen Hinterecken, Areole hinten offen. Schildchen nur ganz wenig eingebuchtet. Elytrengitterung sehr unregelmässig Abb. 21, Behaarung fehlt fast ganz.

Länge, 8 mm., Breite, (Hum.) 1.5 mm.

LUZON (*Boettcher*), 1 Männchen.

Typus in meiner Sammlung.

Von den drei vorhergehenden Arten unterscheidet sich *incertus* sehr leicht durch die ganz andere Ausfärbung. Während bei den vorhergehenden Arten der Prothorax entweder ganz oder doch wenigstens zum Teil gelb gefärbt ist, ist er bei *incertus* schwarz. Die dunklen Farbentöne sind überhaupt tiefer als bei den anderen Arten. Dazu kommt noch, dass der Prothorax durch die vorgezogenen Hinterecken von den der anderen Arten ganz abweicht. Die Elytren, die bei *reliquus* nur im basalen Teil unregelmässig skulptiert sind, haben bei *incertus* nur im spitzen Teil im geringen Umfange reguläre fünfeckige Figuren.

ILLUSTRATION

TAFEL 1

ABB. 1 bis 3. *Macropareia schultzei* sp. nov.; *1*, Kopf; *2*, Fühler; *3*, Tibia und Tarsen der Hinterbeine.

4 bis 6. *Calochromus luzonicus* sp. nov.; *4*, 1. bis 4. Fühlerglied; *5*, Prothorax; *6*, Habitusbild der Ausfarbung.

7. *Libnetis spinicornis* sp. nov.; mittlere Fühlerglieder.

8 bis 11. *Plateros zonatus* sp. nov.; *8*, 1. bis 4. Fühlerglied; *9*, Prothorax; *10*, Penis; *11*, Habitusbild der Ausfarbung.

12 und 13. *Plateros pudens* sp. nov.; *12*, 1. bis 6. Fühlerglied; *13*, Prothorax.

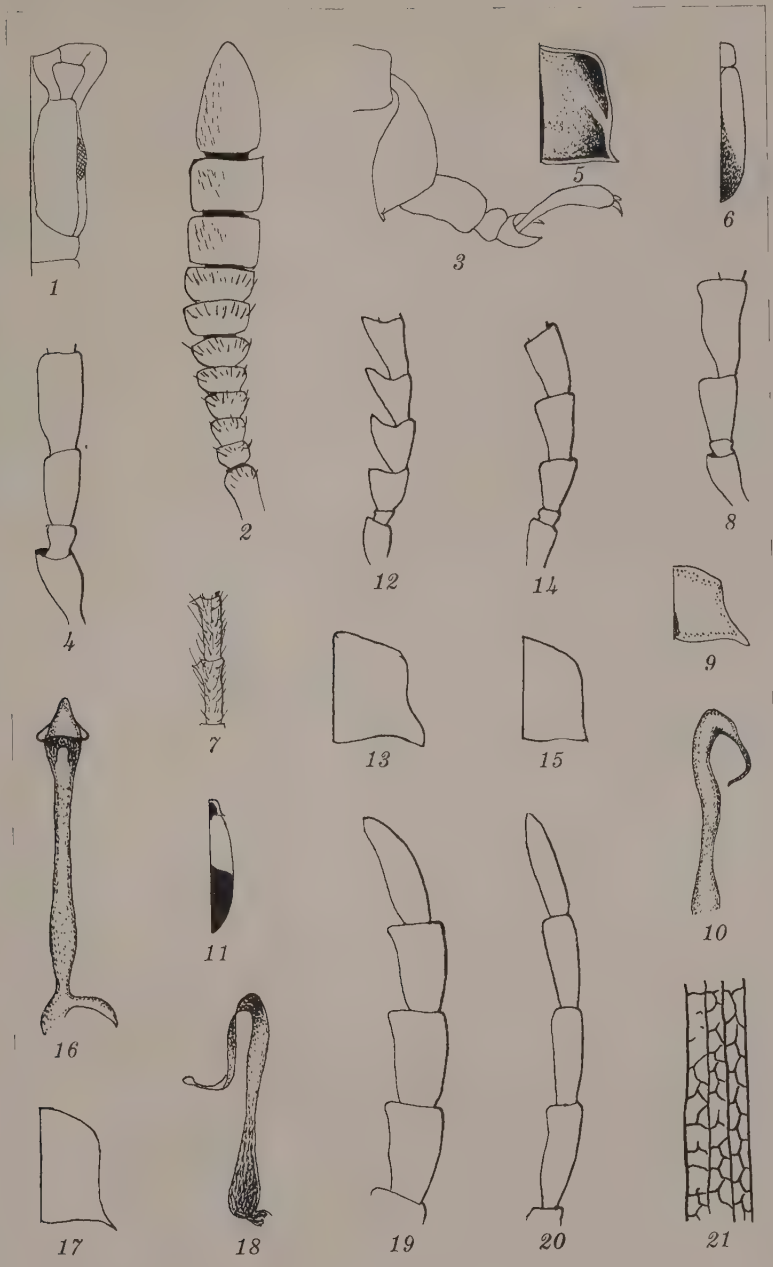
14 bis 16. *Plateros paululus* sp. nov.; *14*, 1. bis 5. Fühlerglied; *15*, Prothorax; *16*, Penis.

17 und 18. *Plateros exiguus* sp. nov.; *17*, Prothorax; *18*, Penis.

19. *Leptotrichalus perversus* sp. nov.; 8. bis 11. Fühlerglied.

20. *Leptotrichalus placitus* sp. nov.; 8. bis 11. Fühlerglied.

21. *Leptotrichalus reliquus* sp. nov. und *L. incertus* sp. nov.; Elytrengitterung.



TAFEL 1.

DETERMINATION OF ORGANIC MATTER IN ACCUMULATOR SULPHURIC ACID SOLUTIONS

By Rollin G. Myers

Chemist, United States Naval Station, Cavite, Philippine Islands

Recently Craig [1] has described a method for the determination of small quantities of formic, acetic, and other volatile organic acids in the sulphuric acid solutions used in lead accumulators. These acids are quite undesirable, especially the acetic acid, because of the corrosive action on the positive plates of the cell. In addition to the acids mentioned, there are also small quantities of organic matter present in the accumulator sulphuric acid. The presence of this organic matter is also objectionable and accordingly only traces are permitted.

Experiments recorded in this paper were carried out with the idea of ascertaining some method suitable for the routine analysis of organic matter in accumulator sulphuric acid solutions. A review of the literature indicates that there is no standard method for this determination.

The presence of organic matter in the sulphuric acid electrolyte of lead accumulators originates from the thin layers of "treated wood separator" placed between the anode plates of the cell. Since the wood is in immediate contact with the electrolyte and for a considerable length of time, hydrolytic changes appear to take place with the formation of substances which are probably decomposition products of cellulose.

However, it is probable that these changes may be modified to a considerable extent through the influence of the electric current passing to and from the cell during cycling. Moreover, it is quite likely that oxidation processes may also take place accompanied by the formation of organic acids such as formic and acetic. According to Craig these acids are actually found in cycled electrolytes.

Perhaps these acids are split off directly by the action of sulphuric acid on the wood cellulose or are formed later through

[1] Bur. Standards Journ. Research 6 (1931) 169.

a breaking down of hydrolyzed cellulose products, like biose or monose. The second supposition, however, seems to merit the greater weight particularly in view of the possible oxidation processes that take place in the cell. Accepting this view as the more probable, any cause tending to increase the organic matter in the electrolyte would also tend to increase the quantities of objectionable acetic and other organic acids. In view of this possibility the determination of the amount of organic matter in the electrolyte has considerable practical importance.

EXPERIMENTAL PROCEDURE

In working out a method for the determination of organic matter in accumulator sulphuric acid solutions it was first thought that a colorimetric method could be developed from the procedure used as a qualitative test for organic matter in the electrolyte. This consists in evaporating a portion of the electrolyte until the fumes of sulphur trioxide appear. If organic matter is present a brown shade develops due, of course, to the charring of the carbonaceous substances in solution. The depth of the brown shade developed naturally depends on the amount of organic matter in solution. Experiments were carried out by evaporating equal weights of standard glucose-sulphuric acid solutions and the electrolyte solution to a maximum color shade. Color comparisons were then made by matching the color shade of equal volumes of the electrolyte with a series of standard glucose solutions ranging from 0.10 to 0.001 per cent. The results were unsatisfactory as the color shades developed in the electrolyte often varied considerably from those of the standard glucose solutions. The development of maximum color shade was also difficult to obtain because if evaporation was continued too long a decided bleaching of the color occurred. Again it was difficult to prevent the precipitation of carbon from its colloidal solution.

The uncertainties noted in the colorimetric method gave added weight to the necessity of determining the organic matter by some gravimetric method in which the experimental conditions could be more accurately controlled. Obviously the separation of the excess sulphuric acid in the electrolyte would seem to be the first step. For this purpose barium carbonate seemed to be an appropriate reagent. However, experiments showed that the barium carbonate separation was not suitable for various

reasons. First, the inconveniently large amounts of insoluble barium sulphate and excess carbonate obtained during the separation of the sulphate radical made it difficult to remove all the organic matter occluded in the precipitate even after several extractions. Again even the "analyzed" barium carbonate used was found to contain appreciable quantities of organic matter. Finally, a series of test determinations made on the same electrolyte showed a considerable variation in the amounts of organic matter found even when the procedure was most carefully carried out.

The difficulties of the barium carbonate separation suggested the use of neutral lead acetate solution as a better means of eliminating the sulphate radical. The lead acetate separation, which proved to be the most successful, was carried out in the following manner: A portion of the electrolyte (about 7 grams) was weighed into a 200-cubic-centimeter Erlenmeyer flask and enough alcohol was added to make the volume of the solution, after the lead sulphate precipitation, consist of about 50 per cent alcohol. The solution was heated to the boiling point and neutral lead acetate solution (25 grams in 100 cubic centimeters of water) was added gradually from a burette until there was a slight excess. If the solution is allowed to boil gently and is agitated vigorously the sulphate radical is precipitated easily and completely. The insoluble sulphate settles out rapidly leaving a clear supernatant solution. After precipitation, the flask containing the insoluble lead sulphate was stoppered loosely, placed in an inclined position, and allowed to cool. The supernatant solution was then decanted into a beaker and the precipitated lead sulphate washed into a centrifuge tube with dilute alcohol (50 per cent). After centrifuging about five minutes the clear solution was poured from the compact lead sulphate into the beaker containing the supernatant solution previously obtained. To insure the elimination of all but traces of organic matter the lead sulphate was again washed with dilute alcohol, centrifuged, and the washings added to the solutions previously separated from the lead sulphate. The combined solutions were then evaporated to a volume of about 30 cubic centimeters. About 0.5 cubic centimeter of glacial acetic acid was added, the solution was heated to the boiling point, and a rapid stream of hydrogen sulphide gas was passed into the hot solution. After digesting on a steam bath for a few minutes the lead sulphide was removed by filtering. The filtrate

was boiled to volatilize the excess hydrogen sulphide and then evaporated to dryness.

To purify the residue it was treated with about 3 cubic centimeters of boiling water. Sufficient barium hydroxide solution was then added to remove the slight amount of iron originally contained in the electrolyte. The mixture was then stirred thoroughly, digested for a few minutes on a steam bath, filtered into a weighed platinum dish, and evaporated to dryness. The residue was then heated to constant weight, at a temperature of about 105° C., after which it was ignited at a low red heat until all the carbon was removed.

In order to check the organic matter that might be contained in the reagents used or introduced during the analysis corresponding blank determinations were carried out using Merck's reagent sulphuric acid which had a specific gravity of 1.198 at $\frac{30°}{30°}$ C. The amount of organic matter found in the blank analyses varied from 0.022 to 0.026 per cent.

Seven typical accumulator electrolytes of various ages were analyzed by the lead acetate method. This method apparently has various advantages. No objectionable voluminous precipitates are obtained as in the barium carbonate separation. Again the excess lead can be easily removed by hydrogen sulphide. Finally, the remaining by-products, acetic acid with some ethyl acetate, present no special difficulty since both compounds can be readily and completely volatilized leaving the desired organic matter in the residue.

Table 1 summarizes the data obtained in these experiments.

SUMMARY

A method for the determination of organic matter in accumulator sulphuric acid solutions has been worked out. This method depends on the use of lead acetate for the removal of excess acid in the electrolyte.

Six electrolytes varying in age from one to five years and one unused electrolyte were analyzed.

Considering the small amount of organic matter contained in the electrolyte and the difficulties of separating it the individual analysis for each sample (Table 1) gave results which agreed fairly well except in the case of sample 2.

The corrected percentage of organic matter found in accumulator sulphuric acid solutions varies from 0.075 to 0.088 per

cent (Table 1). A new solution which had not been used gave 0.003 per cent organic matter.

Apparently, the organic matter does not increase with long continued service. In fact, a solution that was used one year contained even slightly more organic matter than one used for five years.

TABLE 1.—*Organic matter in accumulator sulphuric acid solutions.*

Sample No.	Age of electrolyte.	Analysis No.	Weight of purified residue.[a]	Organic matter.		Sulphuric acid by weight.	Sulphuric acid, specific gravity $\frac{30°}{30°}$ C.
				Obtained in each analysis.	Average results corrected for blank.[b]		
	Years.		*g.*	*Per cent.*	*Per cent.*	*Per cent.*	
1	4.5	1	0.0028	0.109		25.62	1.1930
		2	0.0026	0.093	0.078		
2	4.5	1	0.0024	0.072		27.72	1.2010
		2	0.0025	0.111			
		3	0.0036	0.149			
		4	0.0028	0.112			
		5	0.0020	0.084	0.083		
3	5	1	0.0020	0.093		25.88	1.1872
		2	0.0021	0.092			
		3	0.0020	0.106			
		4	0.0022	0.103	0.075		
4	2	1	0.0027	0.102		25.52	1.1995
		2	0.0020	0.100			
		3	0.0026	0.105	0.079		
5	2.5	1	0.0024	0.110		11.19	1.0748
		2	0.0025	0.112	0.088		
6	1	1	0.0029	0.109		27.36	1.1973
		2	0.0024	0.089			
		3	0.0025	0.096			
		4	0.0031	0.121	0.081		
7	(c)	1	0.0006	0.026	0.003	23.40	1.1698

[a] Residue (before ignition) from 1 gram of electrolyte.
[b] Organic matter found in the blank analysis varied from 0.022 to 0.026 per cent.
[c] Fresh sample not yet used.

COMPOSITION OF SOME PHILIPPINE HARDWOODS, IV [1]

By H. M. CURRAN

Of the Bureau of Forestry, Manila

and

F. M. YENKO, LUZ BAENS, and AUGUSTUS P. WEST

Of the Bureau of Science, Manila

FOUR PLATES

For industries which use wood as their basic raw material the composition of woods is a matter of considerable importance. We have been working several years on the composition of Philippine woods. Three papers have already appeared,[2] and this one makes our fourth report which includes some of the Philippine hardwoods. An account of the general properties of these woods is given by Schneider.[3] Brief descriptions are as follows:

Kayatau (*Dysoxylum turczaninowii* C. DC.) belongs in a genus which has about twenty-five tree species in the Philippines. These different species are widely distributed but always scattered. Kayatau is a straight tree of medium height and grows to a maximum diameter of about 80 centimeters. The wood is hard and moderately heavy with a texture that is fine, dense, and smooth. When fresh the wood has an odor suggesting that of sandal wood. The durability is at least 2, and even the sapwood is rarely attacked by beetles. The wood is useful for posts and general construction work. On account of its beauty of texture, color, and insect-proof qualities it is very suitable for fine cabinet work and beautiful moth-proof chests.

Lago [*Pygeum vulgare* (Koehne) Merr.] is a tree which sometimes reaches a diameter of 60 centimeters. The wood is moderately hard and heavy and is rarely attacked by beetles.

[1] This work is carried on coöperatively by the division of organic chemistry, Bureau of Science, and the Bureau of Forestry.

[2] Yenko, F. M., Luz Baens, A. P. West, and H. M. Curran, Philip. Journ. Sci. 47 (1932) 281 and 343; 48 (1932) 299.

[3] Bull. P. I. Bur. Forestry 14 (1916).

The wood seasons well and is easy to work. The durability is about 3. It is used for posts and general construction work. It is also employed for making picture frames and is a substantial wood for cabinet work.

Lamóg (*Planchonia spectabilis* Merr.) is a tall straight tree which sometimes grows to a diameter of more than 100 centimeters. The wood is hard and moderately heavy with a texture which is rather fine and smooth. It has a durability of 2, is fairly easy to work, and is rarely attacked by insects. It is used for posts and general construction work and makes a beautiful cabinet wood. This species is widely distributed in Luzon and the Visayan islands but is scattered.

Binggas [*Terminalia comintana* (Blanco) Merr.] is a tall, fairly straight tree which may reach a diameter of 100 centimeters or more. The wood is hard and heavy and has a durability of at least 3. The texture is fine and smooth. The wood seasons well and works smoothly, and even the sapwood is not attacked by beetles. It is used for posts, general construction work, furniture, and cabinet work.

Bolon [*Alphonsea arborea* (Blanco) Merr.] is a large forest tree reaching a diameter of from 70 to 80 centimeters with an upright, straight, and regular trunk; crown close and branches more or less horizontal; stem darkish in color; bark very thick and contains bast fibers. The wood is of medium quality as to weight and hardness and is used for light construction and cabinet work. It is not durable in contact with the ground. This species occurs in abundance at low and medium altitudes in central and southern Luzon, Mindoro, Visayan Islands, and Mindanao.

Kariskis [*Albizzia lebbekoides* (DC.) Benth.] is a small to medium-sized tree which may have a diameter of about 40 centimeters. The wood is hard and moderately heavy. It has a durability of 1 and is practically never attacked by beetles. It is used for posts and general construction work, interior finish, furniture, and cabinet work. It is widely distributed but scarce.

Bayanti (*Aglaia llanosiana* C. DC.) belongs to a genus which has about fifty species in the Philippines. These different species are widely distributed but do not grow to a very large size. Bayanti grows to a diameter of about 35 centimeters. The wood is very hard, heavy, and dense. It is one of the finest woods of this genus with a fine and dense texture. It seasons well and has an aromatic odor which is somewhat pungent.

The durability is at least 2. The heartwood is rarely, if ever, attacked by termites or the sapwood by beetles. In localities where this wood occurs it is a favorite for house posts and agricultural implements on account of its strength and durability. It is also very suitable for fine furniture, cabinet work, and moth-proof chests.

Bayok (*Pterospermum diversifolium* Blume) and kulatiñgan (*Pterospermum obliquum* Blanco) are members of a genus which has about seven species in the Philippines. These two species are widely distributed and large enough to furnish saw lumber. Bayok grows to a diameter of about 50 centimeters and kulatiñgan to about 70 centimeters. The wood of these trees is rather hard, tough, and moderately heavy to heavy. The texture is fine and smooth. The wood is used for posts, general construction work, and furniture. Probably good ties and paving blocks could be made from the wood if impregnated.

Next to the lauans the narra family contains the most important timber trees in the Islands, producing a much greater variety of hard, durable, and beautifully colored cabinet woods than any other family. Narra (*Pterocarpus indicus* Willd.) is the most familiar member of this family. The wood of narra is moderately hard to hard and moderately heavy. Of all the common Philippine woods the heartwood of narra is the most variable in color, ranging from pale straw through shades of pink, salmon, and deep red to dull brown. Commercially, narra is classified as "red," "yellow," or "white," but individual specimens may have most any color from light to brown. Narra has a rather fine texture, seasons well, shrinks and checks but little, and hardly warps at all. It is easy to work, has a durability of 2, and is rarely attacked even by termites.

Narra is the most widely known high-grade interior finish, furniture, and cabinet wood in the Philippines and is used for numerous purposes. Most of the single-piece round table tops are made from the buttress roots of narra.

In Table 1 are given the measurements of the trees from which samples were taken for our analyses.

In analyzing the wood samples we followed, in general, the methods adopted by the forest products laboratory at Madison, Wisconsin.[4] Certain details in the analytical procedures [5] which

[4] Bray, M. W., Paper Trade Journ. 87 No. 25 (1928) 59.—Schorger, A. W., Chemistry of Cellulose and Wood (1926) 505.

[5] Yenko, F. M., Luz Baens, A. P. West, and H. M. Curran, Philip. Journ. Sci. 47 (1932) 343.

we found by previous experience to increase the accuracy of the results were introduced.

TABLE 1.—*Measurements of trees used for wood analyses.*

Name of tree.	Diameter.	Total height.	Clear length of trunk.	Height from which specimen was taken.	Specific gravity of wood.
	cm.	*m.*	*m.*	*m.*	
Kayatau; *Dysoxylum turczaninowii*	25	16	12	1.92	0.857
Lago; *Pygeum vulgare*	27	21.5	13.8	2.48	0.753
Lamog; *Planchonia spectabilis*	33	17.1	0.6	2.84	0.872
Binggas; *Terminalia comintana*	28	22	10	2.23	0.906
Bolon; *Alphonsea arborea*	25	21	12	2.12	0.810
Kariskis; *Albizzia lebbekoides*	18	10	3	1.85	0.639
Bayanti; *Aglaia llanosiana*	24	14	5	2.22	1.003
Bayok; *Pterospermum diversifolium*	27	14	5	2.04	0.547
Kulatiñgan; *Pterospermum obliquum*	19	[a] 6.4	6.4	2.08	0.547
Narra; *Pterocarpus indicus*	18	15	5.6	2.25	0.407

[a] The top of this tree was broken.

RESULTS

The results of analyzing the woods recorded in this paper are given in Table 2.

TABLE 2.—*Analyses of Philippine hardwoods.*

[The percentages were calculated on a moisture-free basis.]

Constituent.	Kayatau; *Dysoxylum turczaninowii.*	Lago; *Pygeum vulgare.*	Lamog; *Planchonia spectabilis.*	Binggas; *Terminalia comintana.*	Bolon; *Alphonsea arborea.*
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Cold-water soluble	2.10	1.84	4.59	3.60	2.02
Hot-water soluble	5.22	3.20	9.32	6.54	4.75
Alkali soluble	5.82	16.43	19.95	16.35	13.14
Ether extract	0.69	2.41	1.47	0.24	0.91
Alcohol extract	1.15	1.60	6.38	4.69	2.95
Ash	1.60	0.20	0.44	1.80	0.71
Nitrogen	0.24	0.25	0.30	0.31	0.77
Lignin	35.16	32.84	39.50	35.32	29.97
Cellulose	52.77	52.14	49.57	47.32	52.26
Ash in cellulose	0.66	0.23	0.34	0.28	0.24
Ash-free cellulose	52.11	51.91	49.23	47.04	52.02
Alpha cellulose in total cellulose	77.02	78.49	75.38	75.87	79.14
Alpha cellulose in the wood	40.64	40.92	37.34	35.90	41.36

TABLE 2.—*Analyses of Philippine hardwoods*—Continued.

Constituent.	Kariskis; *Albizzia lebbekoides.*	Bayanti; *Aglaia llanoeiana*	Bayok; *Pterospermum diversifolium.*	Kulatiñgan; *Pterospermum obliquum.*	Narra; *Pterocarpus indicus.*
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Cold-water soluble	1.97	1.48	5.38	1.81	4.68
Hot-water soluble	6.12	3.73	6.44	3.64	9.55
Alkali soluble	14.13	9.62	15.11	12.99	16.92
Ether extract	1.12	0.73	0.70	0.89	0.69
Alcohol extract	5.14	1.92	7.36	3.95	4.18
Ash	0.19	1.34	1.20	0.64	1.05
Nitrogen	0.42	0.27	0.44	0.50	0.55
Lignin	29.28	31.85	36.81	35.05	31.98
Cellulose	53.98	49.21	50.76	54.85	51.21
Ash in cellulose	0.18	0.20	0.29	0.37	0.29
Ash-free cellulose	53.80	49.01	50.47	54.48	50.92
Alpha cellulose in total cellulose	78.90	74.93	75.64	80.11	80.06
Alpha cellulose in the wood	42.59	36.87	38.39	43.94	41.00

TABLE 3.—*Variation in the principal constituents of some Philippine and American hardwoods.*

Kind of wood.	Cellulose.	Lignin.	Alpha cellulose.	
			In wood.	In total cellulose.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Philippine	47.32–54.85	29.28–39.50	35.90–43.94	74.93–80.11
American [a]	48.68–59.40	21.87–32.74	22.67–43.93	42.45–77.38

[a] Data for American woods were taken from analyses of white ash, pignut hickory, yellow birch, white oak, tanbark oak, and shellbark hickory, Ritter, G. J., and L. C. Fleck, Journ. Ind. Eng. Chem. 14 (1922) 1050, and 15 (1923) 1055.

SUMMARY

Ten samples of wood from Philippine hardwood trees were analyzed in this investigation. These woods have the common names kayatau, lago, lamog, binggas, bolon, kariskis, bayanti, bayok, kulatiñgan, and narra.

As shown by the data (Table 2) the kulatiñgan wood has the highest content of cellulose and alpha cellulose. Lamog has the highest lignin and binggas the highest ash content.

The data given in Table 3 show the variation in the principal constituents of the Philippine woods as compared with some American hardwoods. In general, the Philippine woods appear to be more uniform in composition than the American woods.

The Philippine woods have somewhat less total cellulose than the American woods but considerably more lignin and alpha cellulose.

ILLUSTRATIONS

PLATE 1

Kariskis; *Albizzia lebbekoides* (DC.) Benth.

PLATE 2

FIG. 1. Binggas; *Terminalia comintana* (Blco.) Merr.
2. Kayatau; *Dysoxylum turczaninowii* C. DC.

PLATE 3

FIG. 1. Bayok; *Pterospermum diversifolium* Blm.
2. Lamog; *Planchonia spectabilis* Merr.
3. Narra; *Pterocarpus indicus* Willd.

PLATE 4

FIG. 1. Lago; *Pygeum vulgare* (Koehne) Merr.
2. Bayanti; *Aglaia llanosiana* C. DC.
3. Kulatiñgan; *Pterospermum obliquum* Blco.
4. Bolon; *Alphonsea arborea* (Blco.) Merr.

PLATE 1.

1

2

PLATE 2.

1

2

3

PLATE 3.

PLATE 4.

AVIAN MALARIA STUDIES, VII

PLASMOCHIN AS A PROPHYLACTIC DRUG IN SPOROZOITE INFECTIONS OF AVIAN MALARIA [1]

By PAUL F. RUSSELL
Of the International Health Division of the Rockefeller Foundation

and

ANDRES M. NONO
First Assistant, Malaria Investigations, Manila

ONE PLATE

INTRODUCTION

In previous papers (1, 2, 3, 4, 5) one of us has reported some experiments with plasmochin simplex in avian malaria, where attempts at transmitting the disease by blood-saline inoculations of *Plasmodium cathemerium* (Hartman, 1927) from infected birds were invariably prevented by intramuscular injections of as little as 0.00016 gram of this drug in daily doses, provided that the last dose was given subsequent to the infective inoculum. These experiments were successful and although they did not concern sporozoites and were done on birds instead of men yet, naturally enough, led us to further investigations into the possibilities of plasmochin as a prophylactic drug in human malaria and against sporozoite infections in avian malaria.

Not many experiments with plasmochin as a prophylactic in human malaria have been recorded. Fischer (6) gave the drug in doses of 0.059 gram on three consecutive days each week to

[1] These studies are from the laboratory of malaria investigations, of which the senior author is chief, and which is a project jointly supported by the Bureau of Science, Manila, and the International Health Division of the Rockefeller Foundation. Misses J. M. Ejercito and E. Foronda, microscopists of malaria investigations, assisted in the examination of blood smears. We are indebted to the Winthrop Chemical Company, Dr. G. Schwab, local manager, for the plasmochin simplex and the chinoplasmin used in these experiments.

thirty-seven members of a crew on a steamship sailing from Hamburg to West African river ports. Six cases occurred in spite of this attempt at prophylaxis, but the rate of 15 per cent seemed favorable when contrasted with rate of 25 to 30 per cent among the crews of two steamers following the same route on which quinine was used instead of plasmochin to prevent malaria. As reported in one of our experiments(4) plasmochin has a transient effect, not over five hours. Therefore, the men in Fischer's experiments were left unprotected at least four-sevenths of the time.

Ejercito,(7) in the Philippines, gave daily doses of 0.01 gram prophylactic plasmochin with 0.125 gram quinine sulphate to eight individuals and 10 grains of prophylactic quinine sulphate to eight others. Two of the first group and six of the second acquired malaria during eight weeks test.

James, Nicol, and Shute(8, 9, 10) in a small series of controlled experiments with relatively large amounts of plasmochin simplex (the manufacturers have assured us that this is the drug referred to in their work at first as beprochin and later as plasmoquine) found that they could prevent mosquito-borne malarial infections among a group of healthy individuals who took 0.02 gram of the drug on the day before infection and the same dose three times a day thereafter for six days; that is, 0.06 gram on the day of infection and on each of the next five days. These observers stated in their conclusion that they knew from previous tests that "somewhat smaller doses taken over a shorter period are equally effective." What those doses and periods were is not stated.

Swellengrebel and Buck(11) reported a series of experiments along the lines of those by James et al.(9) but using plasmochin in doses which can be tolerated in practice in the field. These authors(11) in their first series gave 0.03 gram of plasmochin simplex daily for six days. On the first day nine plasmochin and three control cases were infected with malaria, each by the bites of at least four rather heavily infected *Anopheles maculipennis* mosquitoes. All were successfully infected and the only effect of the plasmochin was perhaps to shorten the periods of incubation. In a second series they followed the same general procedure but used less heavily infected mosquitoes. Here the plasmochin seemed to prolong the incubation period very slightly and was successful in protecting one out of four cases. The other three and the control became infected.

Swellengrebel and Buck(11) in a third experiment gave one case 0.9 gram of quinine and 0.03 gram of plasmochin daily. Exposure to the bites of several heavily infected mosquitoes resulted in malaria in spite of the quinine and plasmochin.

Recently Russell and Holt(12) reported a field experiment in the Philippines in which it was shown that daily doses of 0.01 gram plasmochin and 0.3 gram quinine sulphate in the form of tablets of chinoplasmin were not always sufficient to prevent the appearance of malaria parasites in the blood, although these doses would occasionally do so and usually forestalled clinical symptoms. Even daily doses of 0.02 gram plasmochin and 0.6 gram quinine sulphate permitted the occasional development of malaria parasites in the blood. Unfortunately, it begins to appear that optimism is to some extent premature and that further search will be necessary to find the practical chemoprophylactic for malaria. Plasmochin is apparently not lethal for sporozoites to the degree it has been shown to be for older asexual forms and for gametocytes. What has been achieved thus far(3, 4, 9) is probably successful early therapy rather than true prophylaxis.

WHAT IS PROPHYLAXIS?

However, it is perhaps quibbling to attempt to analyze such results, as to whether they represent therapy or prevention, for there are no authorized definitions whereby one may make such a separation between early cure and true prophylaxis.

The New English Dictionary,(13) for example, defines "prophylaxis" when used medically as "the preventive treatment of disease." The word "disease" is defined as "a condition of the body, or some part or organ of the body, in which its functions are disturbed or deranged; a morbid physical condition." It also quotes the Sydenham Society Lexicon definition of disease as "a departure from the state of health, especially when caused by structural change."

Webster's(14) dictionary defines "prophylaxis" as the "art of guarding against, preserving from, or preventing, disease; protective, preservative, or preventive treatment."

Gould's(15) medical dictionary defines "prophylaxis" simply as the "prevention of disease; measures preventing the development or spread of disease."

Dorland(16) defines "prophylaxis" as "the prevention of disease. Preventive treatment." The word "disease" is defined as "Any departure from a state of health."

Where among such quotations does one find aid in separating by definition the following hypothetical examples of "prophylaxis"?

(1) Plasmochin applied to the skin repels an infective mosquito and thus is a prophylactic against malaria.

(2) Plasmochin circulating in the blood stream destroys sporozoites immediately after their injection into a capillary by a mosquito and is thus a prophylactic against malaria.

(3) Plasmochin has no effect on the sporozoites but is lethal for the merozoites. The sporozoites undergo full development in the red cells so that there is multiplication of parasites but when the red cell carriers break down the plasmochin destroys the liberated merozoites and thus is a malaria prophylactic.

(4) Plasmochin affects only the gametocytes. They are destroyed or made nonviable. Thus, mosquito infection being impossible, there can be no spread of malaria and plasmochin is a prophylactic against malaria.

(5) Plasmochin sprayed in the air or on water destroys adult or larval mosquitoes and is thus a malaria prophylactic.

It is obvious that, by definition, in the hypothetical case 1 plasmochin is a true prophylactic since there can be no question that it is "a preventive treatment of disease." Case 5 may also be admitted as true prophylaxis although it is not a "treatment" of disease.

Furthermore, case 2 may also be classed as true prophylaxis for the mere injection of sporozoites into the capillaries can scarcely be considered as having caused a state of disease, in that the functions of the body have been deranged only to an infinitesimal degree.

But what of case 3? Is this early treatment or true prophylaxis? Objective but not subjective disease exists and has not been prevented by the plasmochin. Destruction of red blood cells is proceeding. The treatment, therefore, is not preventive but curative, although the patient may not be aware that he has been diseased.

In case 4 there is neither preventive nor curative treatment yet there is "prophylaxis," in a commonly accepted use of the term, because a human malaria carrier having had acute disease and come to a chronic stage, is made noninfective to mosquitoes and thus other cases of malaria are prevented.

Perhaps some day there will be terms to differentiate one type of prophylaxis from another. At present one must assume that

any substance or device which in any way, directly or indirectly, prevents subjective disease is in that case a prophylactic of that disease—defining disease as "any departure from a state of health." This is too broad a definition and in practice is often arbitrarily restricted. Quinine in sufficient doses will cure malaria and thus prevent the spread of this disease to others. If taken continuously it will keep a company of troops, for example, relatively free of symptoms even in highly malarious places, subjective disease appearing only after the men have returned to their nonmalarious base and stopped taking quinine. But the present tendency among malariologists is to refuse the term "prophylactic" to quinine in reference to malaria. In spite of its superiority over quinine as regards its lethal effects on gametocytes it seems doubtful if plasmochin will have much better claim to the title "prophylactic."

The following experiments in avian malaria are in line with the disappointing results in human malaria of Swellengrebel and Buck(11) in the laboratory, and Russell and Holt(12) in the field.

GENERAL PROCEDURE

It is not necessary to describe our general procedure as regards technic of blood inoculations, blood-smear examinations, and the administration of plasmochin. We followed that described fully in previous papers.(3, 4) In those reports were also discussed the usual course of infection and the test of susceptibility in birds which remain negative after attempted infection.

MOSQUITO TECHNIC

All of the mosquitoes used in these experiments were of the species *Culex quinquefasciatus* (*fatigans*). In every case the adults used were reared from larvæ, usually obtained from egg rafts laid in laboratory cages but occasionally from larvæ collected in the field.

Mosquitoes to be infected were put into cages 12 by 12 by 20 inches in size, having wooden frames and suitable cloth netting. Gametocyte-carrying birds were tied in small wire cages 5 by 5 by 5 inches in size. These small bird cages were placed inside the mosquito cage and allowed to remain there usually for one night, sometimes longer (see Plate 1). Mosquitoes showing evidence of a blood meal were segregated in similar cloth cages and kept quiet while sporozoites developed.

The technic of infecting birds was the same, except that in this case the mosquitoes were infected and the birds susceptible.

We had no difficulty in raising adult *Culex* mosquitoes and none in keeping these alive for periods of a month or more.

PLASMODIUM CATHEMERIUM

In the first thirty-eight experiments, from June 12 to September 22, 1931, inclusive, we used the strain of *Plasmodium cathemerium* (Hartman, 1927) that has been used in other experiments in our laboratory.(3, 4, 17, 18) As noted elsewhere(17) the susceptibility of *Culex quinquefasciatus* for *P. cathemerium* as regards oöcysts was 48 per cent in 1930 in our experiments.

In the present series of experiments the infecting power of this *Plasmodium* in *Culex quinquefasciatus* has been low. Of eighty-eight birds, which for one to five nights were exposed, in experiments 1 to 38, to the bites of *Culex quinquefasciatus* mosquitoes, previously fed on gametocyte-carrying birds, only two became infected. Susceptibility was proved in forty-six of the birds, and twenty-nine more were examined frequently for at least two weeks after exposure. Eleven died before the result of the experiment could be known. In other words, since there is no reason to suppose any of the birds were not susceptible, two birds in seventy-seven became infected, an infection rate of 2.6 per cent. The fact that approximately half of the birds in this series had plasmochin makes little difference in the interpretation of these figures since there is no evidence that the drug prevented infection. In fact, the two positive cases each received plasmochin. See Table 1.

PLASMODIUM CAPISTRANI

In experiments 39 to 93, October 12, 1931, to April 9, 1932, we used *Plasmodium capistrani* Russell, 1932.(18) As noted below, in some of the experiments infection was attempted by bites of infected mosquitoes and in others by the injection of saline-sporozoite mixtures. The general results of these experiments with *P. capistrani* are summarized in Table 2. It will be seen that of the two hundred thirteen birds used, eighty-five died too soon after exposure to give definite information. There is no reason to suppose that any of the remaining one hundred twenty-eight were not susceptible to *P. capistrani.* Nor did the plasmochin prevent infection. So we may consider the infection rate for *P. capistrani* as 36.7 per cent.

When it is considered that in all respects the technic of handling the mosquitoes and birds was the same it is interesting that the infection rate in *P. cathemerium* was only 2.6 per cent whereas it was 36.7 per cent in *P. capistrani.* It is very difficult to explain this fact, especially since the oöcyst rate for *P. cathemerium* in 1930, using the same general technic and species of *Culex,* was 48 per cent.(17) What the sporozoite rate was at the same time we do not know, but in October, 1930, a batch of one hundred five *Culex quinquefasciatus* mosquitoes were dissected fifteen to twenty-five days after feeding on gametocyte carriers of *P. cathemerium.* In this lot there were forty oöcyst and thirty-two sporozoite infections, rates of 38.1 per cent for oöcysts and 30.5 per cent for sporozoites. Why there has been a marked change in the behavior of this parasite we cannot state. It is, of course, interesting to speculate whether or not similar changes occur in the plasmodia of man.

RESULTS OF EXPERIMENTS

Many of the ninety-three experiments in the series we are reporting were inconclusive and are not given in detail. In every experiment where controls as well as the birds receiving plasmochin remained negative the experiment was considered to be inconclusive. Only those experiments in which either the control or the plasmochin bird or both became infected are reported in detail below. A summary of the complete series has been presented in Tables 1 and 2. It is to be noted that we believe our technic in the negative experiments differed in no particular way from that used in the successful tests. Conditions were standard throughout, the only change being that already noted, from *P. cathemerium* to *P. capistrani.* In other words we cannot explain the negative results except on the general basis of the well-known natural variations in the susceptibility of mosquitoes to infections(19, 20) and a little understood and perhaps nonexistent immunity of certain birds to sporozoite infection. We found no canary immune to blood-saline inoculations of *P. capistrani* in over three hundred successive cases.

The first successful experiments were Nos. 19 and 21, which are displayed in Table 3. In the first case birds Y17 and Y18 were kept for five nights in a cage of mosquitoes which had fed on gametocyte-carrying birds L83, L95, L96, and L98, twenty-three days before the beginning of the experiment on July 20. On the mornings of July 21, 22, 23, 24, 25, and 26, at approxi-

mately 9 o'clock, bird Y18 was given an intramuscular injection of 0.00002 gram of a solution of plasmochin simplex. This solution was prepared by adding 4 cubic centimeters of distilled water to 1 cubic centimeter of plasmochin simplex solution as sold in ampoules. As stated on the label, this volume of plasmochin simplex solution contains 0.01 gram of plasmochin. Thus, 5 cubic centimeters of the resulting solution contained the 0.01 gram of plasmochin. Of this solution 0.1 cubic centimeter, or 0.0002 gram plasmochin constituted the daily injection. Bird Y17 was not given plasmochin. Both birds were negative for malaria by 30-minute blood-smear examinations July 20 and 27. Bird Y17 remained negative to repeated examinations until August 25 and died the 29th; but bird Y18, in spite of its plasmochin, became positive July 29, heavily so July 31, and died of its malaria August 7.

Experiment 21 was a replica of No. 19. The bird receiving plasmochin, Y30, became infected, but the control, Y31, did not. The latter was subsequently proved to be a susceptible bird by blood-saline inoculation. In both of these experiments the parasite was *Plasmodium cathemerium*. Hereafter, in this report, all experiments referred to were done with *Plasmodium capistrani*.

In Table 4 are summarized experiments 49, 51, 52, and 79, in each of which the birds were exposed to the bites of infected mosquitoes for only one night and the drug was given before and after this exposure. The dose of plasmochin simplex, in experiments 49, 51, and 52, was the same as used in the first two experiments reported above; namely, 0.0002 gram. In experiment 79 half of this amount was given each time, but injections were made at 8.45, 9.45, and 10.45 on the night of exposure and again the following morning at 6 a. m.

In each of these experiments the bird receiving plasmochin, D33, D37, D39, and J69, became infected in spite of the drug. One of the control birds, D40, was also infected. Control birds D34 and J70 were subsequently proved to be susceptible by blood-saline inoculations.

In experiments 39, 41, and 43 chinoplasmin was used instead of plasmochin simplex, the birds being exposed to infection for one night. The chinoplasmin is sold in ampoules of 2 cubic centimeters of a solution containing 0.02 gram plasmochin, 0.6 gram quinine hydrochloride, and 0.1 gram glucose. We diluted 2 cubic centimeters of this with 18 cubic centimeters of distilled

water. Each intramuscular injection consisted of 0.05 cubic centimeter; that is, of 0.00005 gram plasmochin simplex and 0.0015 gram quinine hydrochloride. Bird C71 was given this amount daily for five days beginning on the morning after exposure. This bird became positive October 26, fourteen days after infection. The control bird, C70, which received no chinoplasmin, died too soon to be of any use in the experiment.

The same daily dose of chinoplasmin was given to birds C82 and D3, four times to the former and eight times to the latter, in each case beginning on the afternoon preceding the night of exposure. Each of these birds became infected in spite of the chinoplasmin. In each case the control bird also became infected, as shown in Table 5.

In experiments 48, 72, and 73, summarized in Table 6, both plasmochin simplex and chinoplasmin were used without success as prophylactics. Bird D25 received chinoplasmin, in the doses mentioned above, at 9 a. m. the day preceding the night of exposure. That afternoon it received 0.0002 gram of plasmochin simplex. The morning after exposure it was given another injection of the same amount of plasmochin simplex and the next day an injection of chinoplasmin. Yet it became infected after an incubation period two days shorter than that of its control bird D26. Bird Y91 received its first injection of plasmochin simplex at 11 p. m. the night of exposure and a second dose at 6 a. m. the following morning, with chinoplasmin the next day. This bird became infected, although its control Y92 did not. The susceptibility of Y92 was later proved by blood-saline inoculations. The same procedure was followed in bird Y93 which, with its control, became infected.

In Table 7 are shown the results of experiments 56, 57, 58, 66, 76, 77, and 81 in which the birds were exposed to infective mosquitoes for only two to three hours and not all night. In the first four experiments the usual dose of 0.0002 gram of plasmochin simplex was given just before and just after the birds were put into the mosquito cage, and again early the following morning. In the fourth experiment an additional dose was given on the second morning. Bird D55 died too soon to be of use, but its control bird became positive. Birds D57, D59, and D87 became infected in spite of the plasmochin. D56 and D58, control birds, become infected, but control bird D88 did not although it was later proved to be susceptible to a blood-saline inoculation.

In experiments 76, 77, and 81 plasmochin was given not only at the beginning and end of a two-hour exposure period but also in the middle of this period. That is, injections were made at 8.45, 9.45, and 10.45 p. m. with exposure to infective mosquitoes only from 8.45 to 10.45 p. m. It was necessary to reduce the dose to 0.0001 gram to avoid killing the birds. In these three experiments birds J64 and J73 became infected in spite of the plasmochin, but J65 did not. The control bird for J65 became infected, so that in this experiment, 77, the plasmochin may have had a true prophylactic effect. However, the control birds in experiments 76 and 81 did not become infected, so that it is not possible to point to experiment 77 as a clean-cut example of prophylactic plasmochin.

In all of the above experiments, Tables 3 to 7, infection was attempted by exposure to the bites of mosquitoes. The average number of mosquitoes in a cage was about twenty-five and the average number feeding on the two birds, control and experimental, was about twelve. It was not possible to determine whether more fed on one than on the other bird in a cage, but as each was tied in the same way it is not likely that there was much difference.

SPOROZOITE-SALINE INJECTIONS

Tables 8 to 11 summarize the results of experiments 60, 75, 40, and 46. These were experiments in which infection of the birds was attempted by needle injections of sporozoite-saline mixtures instead of by mosquito bites. This method fixed the time of inoculations exactly in relation to the injection of plasmochin.

In experiment 60, Table 8, seventy-five mosquitoes were used. These had fed on a gametocyte-carrying bird, D4, twenty days prior to this experiment. Wings, legs, head, and abdomen were carefully dissected away from the thorax of each mosquito, quieted by a minimum amount of chloroform. A thorax-saline mixture was made by grinding the material in a mortar and pestle, using 3 cubic centimeters of physiologic saline. Each bird, D71, D72, D73, D74, D75, and D76, received an injection of 0.2 cubic centimeter of the mixture at 9 a. m. Birds D71, D73, and D75 had received 0.0002 gram of plasmochin simplex at 8.50 a. m.; that is, ten minutes prior to the sporozoite injection. The drug was received in the left and the sporozoites in the right breast. The inoculum was perhaps equivalent to the total

sporozoite content of five mosquitoes, a rather large infective dose. This, however, assumes that all of the mosquitoes were infected, which is very doubtful. Two birds failed to become infected. One, D73, had had plasmochin and the other, D76, had not.

The general procedure in experiment 75, Table 9, was the same as in the one just described. In this experiment, No. 75, however, a smaller inoculum was used and plasmochin was given not only just prior to the injection of sporozoites but also in the same dose four and one-half hours later. The same number of mosquitoes were used, but they had been kept thirty-three days after infection. The mixture contained 4 cubic centimeters of saline instead of 3 and the inoculum was 0.15 cubic centimeter of the mixture instead of 0.2 as in experiment 60. Thus, each bird received, perhaps, the equivalent of the total sporozoite content of 2.7 mosquitoes.

In this experiment, of the six birds Y97, Y98, Y99, Y100, J59, and J60, only two became infected. One, Y99, had received plasmochin and the other, Y98, had not. The incubation period was the same in each bird. Birds Y97, Y100, and Y60 died too soon to be of any use.

In experiment 40, Table 10, chinoplasmin was used instead of plasmochin simplex. The dose, 0.00005 gram plasmochin and 0.0015 gram quinine hydrochloride, was given ten minutes before the sporozoites and was repeated on the three succeeding days. In this case, seventy mosquitoes were used with 4 cubic centimeters of physiologic saline. Birds C72 to C81 were used and of these birds C72, C76, and C79 died promptly. Birds C73, C74, and C75 were, therefore, the chinoplasmin birds and of these only C73 became infected. Birds C74 and C75 were subsequently proved to be susceptible by blood-saline inoculation. Of the four useful control birds only one, C78, became infected. Bird C77, C80, and C81 remained negative without the aid of drugs. Bird C80 was subsequently proved to be susceptible. This experiment is further proof of the need for an adequate number of controls in such studies. To say that only one out of three chinoplasmin birds became infected may seem significant until it is realized that only one out of four control birds, inoculated in the same way but having no prophylactic, became infected.

In experiment 46, Table 11 seventy-five mosquitoes with 4 cubic centimeters of saline were used. Of this mixture the

inoculum consisted of 0.2 cubic centimeter. Chinoplasmin, in the usual dose given above, was administered not only just before the sporozoites but also on the four following mornings. Birds D9 to D32 were used. Of these, birds D9, D11, D14, D16, D19, and D22 died promptly. Birds D13, D15, and D18 did not live long enough to be conclusively negative. That left of the chinoplasmin birds, D10 and D12. For controls there were left birds D17, D20, and D21. One of the two chinoplasmin birds became infected in spite of the drug. The other, D10, remained negative until proved to be a susceptible bird by blood-saline inoculation. One of the three control birds, D21, became infected. The other two remained negative without the aid of chinoplasmin and were subsequently proved to be susceptible by blood-saline injections.

SPOROZOITE-PLASMOCHIN MIXTURE

In experiment 82, Table 12, the experimental procedure was changed by adding the plasmochin directly to the sporozoite-saline mixture. Using one hundred sixty-two mosquitoes with 6 cubic centimeters of physiologic saline, a mixture was made in the usual way. Of this mixture, well stirred, 2.7 cubic centimeters were put in a small glass beaker, into which was also added 0.3 cubic centimeter of the usual plasmochin simplex solution as prepared in our laboratory and described above. This added 0.0006 gram plasmochin simplex to the sporozoite mixture and this combination was allowed to stand for fifteen minutes. At the end of this time 0.1 cubic centimeter of the sporozoite-saline-plasmochin mixture was injected into each of six birds, J75 to J80. Immediately thereafter 0.1 cubic centimeter of the original sporozoite-saline mixture (no plasmochin), which had also been standing in a glass beaker for fifteen minutes, was injected into each of six birds, J81 to J86.

We do not know the volume of a canary's blood but estimate it at about 1 cubic centimeter. The maximum amount of plasmochin which can be tolerated without symptoms is 0.0002 gram, and this is a therapeutic dose. In the experiment we are describing, the amount of plasmochin mixed with the sporozoites, therefore, makes a concentration which is probably of the same magnitude as, or slightly greater than, the concentration of this drug in the blood of a bird following the usual injections.

Of the birds used in this experiment J76, J78, and J82 died within a day or two. There remained, therefore, four birds which received the sporozoite-saline-plasmochin mixture; namely, J75, J77, J79, and J80. Three of these, J77, J79, and J80, became infected in spite of the plasmochin. Of the five controls which lived long enough to be of service, all became infected. The average prepatent period in the plasmochin birds was 13 days, in the controls 10.4 days. It seems possible that plasmochin had some direct action on the sporozoites, but it was not great and is not proven by this experiment. Other experiments, 83 to 93, were not successful, all of the birds either dying too soon to be of service or else all, controls and plasmochin birds alike, remaining negative. All attempts at infecting birds with sporozoite-saline-plasmochin or with the plain sporozoite-saline mixtures after half hour or one-hour delays failed.

PLASMOCHIN-BLOOD-SALINE INJECTIONS

In the final experiment we mixed plasmochin with a blood-saline inoculum (no sporozoites). Approximately 0.3 cubic centimeter of blood from bird Z42, which had a one-plus blood smear at the time, was added to 6 cubic centimeters of physiologic saline. To 2.7 cubic centimeters of this mixture was added 0.3 cubic centimeter, or 0.0006 gram, of the laboratory solution of plasmochin simplex, prepared as noted above. After fifteen minutes birds S88, S89, and S90 were each given 0.1 cubic centimeter of the blood-saline-plasmochin mixture, and birds S85, S86, and S87 were then given 0.1 cubic centimeter of the plain blood-saline mixture. All three of these last-named control birds became infected. Only one, S90, of the three birds receiving blood-saline-plasmochin mixture became infected. The other two were subsequently proved to be susceptible birds. In this experiment the plasmochin apparently had a definite inhibitory effect.

CONCLUSIONS

1. Although plasmochin acts in vivo on the asexual stages of *Plasmodium cathemerium* to prevent the development of infection by needle inoculations and acts similarly, as concluded below, on the asexual forms of *Plasmodium capistrani* in vitro to prevent inoculation, neither plasmochin simplex nor chinoplasmin, in the maximum doses which will not cause toxic symptoms, is a prophylactic against avian malaria when sporozoites are injected either in saliva by mosquitoes or in saline mixtures by needle.

2. Plasmochin simplex in actual contact with the sporozoites of avian malaria for fifteen minutes in a glass beaker does not destroy or inactivate them.

3. Plasmochin simplex in actual contact with the asexual forms of *Plasmodium capistrani* for fifteen minutes in a glass beaker appears to have an inactivating or destructive effect on them.

TABLE 1.—*Summary of general results of experiments 1 to 38 with Plasmodium cathemerium and prophylactic plasmochin.*[a]

Description.	Classification.				
	+	O	S	D	T
Birds not receiving plasmochin:					
Number	0	40	27	5	45
Per cent	0				
Birds receiving plasmochin:					
Number	2	35	19	6	43
Per cent	4.7				
Total number	2	75	46	11	88
Total per cent	2.3				

[a] +, bird became infected.

O, bird did not become infected as determined by 30-minute examination of blood smears for a period of at least fourteen days after exposure.

S, number of negative birds in group O for which it was possible to prove definite susceptibility to *P. cathemerium* by subsequent blood inoculations.

D, birds dying less than fourteen days after exposure. (None positive.)

T, total birds used, the sum of columns +, O, and D.

TABLE 2.—*Summary of general results of experiments 39 to 93 with Plasmodium capistrani and prophylactic plasmochin.*[a]

Description.	Classification.				
	+	O	S	D	T
Birds not receiving plasmochin:					
Number	24	46	36	32	102
Per cent	23.5				
Birds receiving plasmochin:					
Number	23	35	19	53	111
Per cent	20.7				
Total number	47	81	42	85	213
Total per cent	22.1				

[a] +, bird became infected.

O, bird did not become infected, as determined by 30-minute examination of blood smears for a period of at least fourteen days after exposure.

S, number of negative birds in group O for which it was possible to prove definite susceptibility to *P. capistrani* by subsequent blood inoculations.

D, birds dying less than fourteen days after exposure. (None positive.)

T, total birds used, the sum of columns +, O, and D.

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TABLE 3.—*Attempts to use plasmochin simplex as a prophylactic in avian malaria in mosquito-borne infections. Birds exposed five nights to bites of mosquitoes infected with Plasmodium cathemerium.*

Experiment No.	Date.	Mosquitoes infected.		Bird No.—	Prophylaxis, if any.			Results. Blood smears.			Died.	Remarks.
		From bird No.—	Days before experiment.		Drug.	Amount.	Given.	Negative.	+ ++	+++ ++++ +++++		
	1931					*g.*						
		L83	23	Y17	None.			July 20, 27, to Aug. 25.			Aug. 29, 1931.	
19	July 20–26	L95	23									
		L96	23	Y18	[a] P.S.	0.0002	July 21, 22, 23, 24, 25, 26, 9 a. m.	July 20–27	July 29–30	July 31; Aug. 1–6.	Aug. 7, 1931	
		L98	23									
				Y30	[a] P.S.	0.0002	Aug. 10, 11 12, 13, 14, 15, 9 a. m.	Aug. 9–23	Aug. 25, 27; Sept. 2, 4.	Aug. 29, 31	Mar. 20, 1932	
21	Aug. 9–14	N1	20									
				Y31	None.			Aug. 9 to Sept. 7.			Sept. 15, 1931.	Susceptibility proved.

[a] Plasmochin simplex.

TABLE 4.—*Attempts to use plasmochin simplex as a prophylactic in avian malaria in mosquito-borne infections. Birds exposed for one night to bites of mosquitoes infected with Plasmodium capistrani.*

Experiment No.	Date	Mosquitoes infected. From bird No.—	Mosquitoes infected. Days before experiment.	Bird No.—	Prophylaxis, if any. Drug.	Amount.	Given.	Results. Blood smears. Negative.	+ ++	+++ ++++ +++++	Died.	Remarks.
	1931					g.						
49	Dec. 3	C87	28	D33	[a] P.S.	0.0002	Dec. 3, 4 p. m; Dec. 4, 7.15 a. m.	Dec. 3, 12	Dec. 14, 16	Dec. 18, 19, 21.	Dec. 21, 1931	
			28	D34	None.			Dec. 3, 1931; Jan. 2, 1932.			Jan. 16, 1932	Subsequently proved to be susceptible.
51	Dec. 3	C78	26	D37	[a] P.S.	0.0002	Dec. 3, 4 p. m; Dec. 4, 7.15 a. m.	Dec. 3	Dec. 12	Dec. 14, 16, 18, 19.	Dec. 21, 1931	
		C86	26	D38	None.			Dec. 3 Jan. 2			Jan. 3, 1932	
52	Dec. 9	C89	23	D39	[a] P.S.	0.0002	Dec. 9, 7 p. m; Dec. 10, 7.30 a. m.	Dec. 9	Dec. 26, 28, 29.	Dec. 19, 22, 24.		Still alive.
			23	D40	None.			Dec. 9, 19, 22	Dec. 24, 26	Dec. 28, 29		Do.
79	Jan. 22	D54	23	J69	[a] P.S.	0.0001	Jan. 22, 8.45, 9.45, 10.45 p. m.; Jan. 23, 6 a. m.	Jan. 22, 28, 30; Feb. 1.	Feb 3	Feb. 5, 8, 10	Apr. 10, 1932; killed.	
		D56	23	J70	None.			Jan. 22, 28, 30; Feb. 1–18.			Feb. 26, 1932	Subsequently proved to be susceptible.

[a] Plasmochin simplex.

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TABLE 5.—*Attempts to use chinoplasmin as a prophylactic in avian malaria in mosquito-borne infections. Bird exposed for one night to bites of mosquitoes infected with Plasmodium capistrani.*

Experiment No.	Date.	Mosquitoes infected. From bird No.—	Mosquitoes infected. Days before experiment.	Bird No.—	Prophylaxis, if any. Drug.	Prophylaxis, if any. Amount.	Prophylaxis, if any. Given.	Results. Blood smears. Negative.	Results. Blood smears. + ++	Results. Blood smears. +++ ++++ +++++	Died.
						g.					
39	Oct. 12	C48	26	C70	None.			Oct. 12			Oct. 16, 1931.
			26	C71	Chin.	P.S., 0.00005 Q., 0.0015	Oct. 13, 14, 15, 16, 17, 9 a. m.	Oct. 12		Oct. 26, 27, 28, 30.	Oct. 31, 1931.
41	Oct. 15	C48	24	C82	Chin.	P.S., 0.00005 Q., 0.0015	Oct. 15, 16, 17, 18.	Oct. 15, 24, 25, 26.	Oct. 27, 29, 31.		Jan. 5, 1932.
		C53	24	C83	None.			Oct. 15, 24	Oct. 25, 27, 29, 31.		Mar. 20, 1932.
43	Nov. 16	C71	20	D3	Chin.	P.S., 0.00005 Q., 0.0015	Nov. 16, 8.30 p. m.; 17, 18, 19, 20, 21, 22, 23.	Nov. 16	Nov. 24		Nov. 26, 1931.
			20	D4	None.			Nov. 16	Nov. 24	Nov. 27; Dec. 1, 3.	De. 5, 1931.

[a] P.S., plasmochin; Q, quinine hydrochloride; Chin., chinoplasmin..

TABLE 6.—*Attempts to use both chinoplasmin and plasmochin simplex as a prophylactic in avian malaria in mosquito-borne infections. Birds exposed for one night to bites of mosquitoes with Plasmodium capistrani.*

Experiment No.	Date.	Mosquitoes infected. From bird No.—	Mosquitoes infected. Days before experiment.	Bird No.—	Prophylaxis, if any. Drug.	Amount.	Given.	Results. Blood smears. Negative.	+ ++	+++ ++++ ++++++	Died.	Remark.
						g.						
				D25	Chin.	P.S., 0.00005 Q., 0.0015	Nov. 24, 9 a. m.; Nov. 26.	Nov. 24; Dec. 1.	Dec. 3, 5, 7, 17.	Dec. 8	Jan. 6, 1932	
	Nov. 24	C87	20		P.S.	0.0002	Nov. 24, 4 p. m.; Nov. 25.					
				D26	None.			Nov. 24; Dec. 1, 3.	Dec. 5, 7	Dec. 8	Dec. 12	
				Y91	P.S.	0.0002	Jan. 13, 11 p. m.; Jan. 14, 6 a. m.	Jan. 13, 19	Jan. 21, 23, 25, 30.	Jan. 26, 28	Mar. 20, 1932; killed.	
72	Jan. 13	D61	22									
		D64	22	Y91	Chin.	P.S., 0.00005 Q., 0.0015	Jan. 15					Subsequently proved to be susceptible.
				Y92	None.			Jan. 13–28; Feb. 17–24.			Mar. 4, 1932.	
				Y93	P.S.	0.0002	Jan. 13, 11 p. m.; Jan. 14, 6 a. m.	Jan. 13, 19		Jan. 23, 25	Jan. 26, 1932.	
73	Jan. 13	D62	21									
		D63	21		Chin.	P.S., 0.00005 Q., 0.0015	Jan. 15					
				Y94	None.			Jan. 13	Jan. 19	Jan. 21, 23, 25, 26, 28, 30.	Mar. 20, 1932; killed.	

TABLE 7.—*Attempts to use plasmochin simplex as a prophylactic in avian malaria in mosquito-borne infection. Birds exposed only for two to three hours to bites of mosquitoes infected with Plasmodium capistrani.*

Experiment No.	Date.	Mosquitoes infected.		Bird No.—	Prophylaxis, if any.			Results. Blood smears.			Died.	Remarks.
		From bird No.—	Days before experiment.		Drug.	Amount.	Given.	Negative.	+ ++	+++ ++++ +++++		
						g.						
56	Dec. 14	D2	21	D54	None.			Dec. 14, 21	Dec. 23	Dec. 26, 28	Dec. 31, 1931	
				D55	P.S.	0.0002	Dec. 14, 8.20, 11.20 p. m.; Dec. 15, 5.45 a. m.	Dec. 14			Dec. 16, 1931	
57	Dec. 14	D2	21	D56	None.			Dec. 14	Dec. 21	Dec. 23. 26, 28.	Feb. 12, 1932	
				D57	P.S.	0.0002	Dec. 14, 8.20, 11.20 p. m.; Dec. 15, 5.45 a. m.	Dec. 14, 21, 23.	Dec. 26	Dec. 28, 30	Dec. 31, 1931	
58	Dec. 14	D1	20	D58	None.			Dec. 14, 21, 23.	Dec. 26, 28, 31.			Still alive.
				D59	P.S.	0.0002	Dec. 14, 8.20, 11.20 p. m.; Dec. 15, 5.45 a. m.	Dec. 14, 21, 23.	Dec. 26		Dec. 28, 1931	

66	Dec. 30	D21	20	D87	P.S.	0.0002	Dec. 30, 9.40, 11.50 p. m.; Dec. 31, 8.30 a. m.; Jan. 1, 9 a. m.	Dec. 30	Jan. 7, 9	Jan. 11, 13, 15.		Still alive.
				D88	None.			Dec. 30; Jan. 7, 27.			Apr. 7, 1932	Subsequently proved to be susceptible.
76	Jan. 22	D54	24	J62	None.			Jan. 22, 28, 30; Feb. 1–18.			Apr. 10, 1932; killed.	Do.
		D56	24	J64	P.S.	0.0001	Jan. 22, 8.45, 9.45, 10.45 p. m.	Jan. 22, 28	Jan. 30; Feb. 1, 3, 8.	Feb. 5	Apr. 10, killed.	
77	Jan. 22	D54	23	J65	P.S.	0.0001	Jan. 22, 8.45, 9.45, 10.45 p. m.	Jan. 22, 28, 30; Feb. 1–18.			Apr. 23, 1932	
		D56	23	J66	None.			Jan. 22, 28, 30.	Feb. 1–3	Feb. 5	Feb. 7, 1932	
81	Jan. 22	D54	24	J73	P.S.	0.0001	Jan. 22, 8.45, 9.45, 10.45 p. m.	Jan. 22, 28, 30, Feb. 1–3.	Feb. 5–10	Feb. 8	Apr. 10, 1932; killed.	
		D56	24	J74							Apr. 10, 1932; killed.	Subsequently proved to be susceptible.

TABLE 8.—*Results of experiment 60 in which plasmochin simplex was used in an attempt to prevent infections of P. capistrani.*

Date.	Mosquitoes infected.		Bird No.—	Prophylaxis, if any.			Results. Blood smears.			Died.
	From bird No.—	Days before experiment.		Drug.	Amount.	Given.	Negative.	+ ++	+++ ++++ +++++	
					g.					
		20	D71	P.S.	0.0002	Dec. 22, 8.50 a. m.	Dec. 22, 29, 31	Jan. 2, 4, 6, 11	Jan. 8	[a] 1931.
		20	D72	None.			Dec. 22, 29	Dec. 31; Jan. 2, 4, 6, 8.		Feb. 20, 1932.
Dec. 22, 1931	D4	20	D73	P.S.	0.0002	Dec. 22, 8.50 a. m.	Dec. 22			Dec. 23, 1931.
		20	D74	None.			Dec. 22	Jan. 2, 4	Jan. 6, 8	Jan. 9, 1932.
		20	D75	P.S.	0.0002	Dec. 22, 8.50 a. m.	Dec. 22	Jan. 2, 4		Jan. 6, 1932.
		20	D76	None.			Dec. 22, 29, 31; Jan. 2.			Jan. 3, 1932.

[a] Still alive.

TABLE 9.—*Results of experiment 75 in which plasmochin simplex was used in an attempt to prevent infections of P. capistrani in birds by sporozoites-saline injections.*

Date.	Mosquitoes infected.		Bird No.—	Prophylaxis, if any.			Results. Blood smears.			Died.
	From bird No.—	Days before experiment.		Drug.	Amount.	Given.	Negative.	+ to ++	+++ to +++++	
		33	Y97	P.S.	g. 0.0002	Jan. 19 11.20 a. m., 3.30 p. m.	Jan. 19			Jan. 20, 1932.
		33	Y98	None.			Jan. 19 to Feb. 1.	Feb. 3, 5, 6		Mar. 20, 1932; killed.
Jan. 19, 1932	D21 D25	33	Y99	P.S.	0.0002	Jan. 19, 11.20 a. m., 3.30 p. m.	Jan. 19 to Feb. 1.	Feb. 3, 5, 6		Do.
				Chin.		Jan. 20				
		33	Y100	None.			Jan. 19			Jan. 20, 1932.
		33	J59	P.S.	0.0002	Jan. 19, 11.20 a. m., 3.30 p. m.	Jan. 19–29			Jan. 31, 1932.
		33	J60	None.			Jan. 19			Jan. 20, 1932.

TABLE 10.—*Results of experiment 40 in which chinoplasmin was used in an attempt to prevent infections of P. capistrani in birds by sporozoites-saline injections.*

Date.	Mosquitoes infected.		Bird No.—	Prophylaxis, if any.			Results. Blood smears.			Died.	Remarks.
	From bird No.—	Days before experiment.		Drug.	Amount.	Given.	Negative.	+ ++	+++ ++++ +++++		
					g.						
		28	C72	Chin.	P.S., 0.0005 Q., 0.0015	Oct. 15, 16, 10 a. m.				Oct. 17, 1931.	
		28	C73	Chin.	P.S., 0.0005 Q., 0.0015	Oct. 15, 16, 17, 18, 10 a. m.	Oct. 15, 26	Oct. 28, 29, 30.		Nov. 11, 1931.	
		28	C74	Chin.	P.S., 0.0005 Q., 0.0015	Oct. 15, 16, 17, 18, 10 a. m.	Oct. 15, 26, 28, 30; Nov 1–9			Nov. 29, 1931.	Subsequently proved susceptible.
		28	C75	Chin.	P.S., 0.0005 Q., 0.0015	Oct. 15, 16, 17, 18, 10 a. m.	Oct. 15, 26, 28, 30, Nov. 1–9			Jan. 15, 1932.	Do.
Oct. 15, 1932	C48	28	C76	Chin.	P.S., 0. 0005 Q., 0.0015	Oct. 15, 10 a. m.				Oct. 16, 1931.	
		28	C77	None.			Oct. 15, 27, 29, 31; Nov. 1–9				
		28	C78	Chin.			Oct. 15, 27, 29, 31.	Nov. 1, 2,	Nov. 6, 7 9.	Nov. 9, 1931.	
		28	C79	Chin.						Oct. 17, 1931.	

Oct. 15, 1932	C48	28	C80	None.							Nov.	19	Do.
		28	C81	None.			Oct. 15, 27, 29, 31; Nov. 1–9				Nov.	15	
							Oct. 15, 27, 29, 31; Nov. 1–9						

TABLE 11.—*Results of experiment 46 in which chinoplasmin was used in an attempt to prevent infections of P. capistrani in birds by sporozoites-saline injections.*

Date.	Mosquitoes infected.		Bird No.—	Prophylaxis, if any.			Results. Blood smears.			Died.	Remarks.
	From bird No.—	Days before experiment.		Drug.	Amount.	Given.	Negative.	+ ++	+++ ++++ +++++		
					g.						
		24	D9	Chin.	{P.S., 0.00005 Q., 0.0015}	Nov. 20, 2.40 p. m., Nov. 21, 22, 23.	Nov. 20	----------	----------	Nov. 24, 1931.	
		24	D10	Chin.	{P.S., 0.00005 Q., 0.0015}	Nov. 20, 2.40 p. m., Nov. 21, 22, 23, 24, 25, 26.	Nov. 20, 28; Dec. 1–21	----------	----------		Still alive May 1, 1932. Subsequently proved susceptible.
		24	D11	Chin.	{P.S., 0.00005 Q., 0.0015}	Nov. 20, 2.40 p. m., Nov. 21, 22, 23, 24.	Nov. 20	----------	----------	Nov. 25	
Nov. 20, 1931	C71	24	D12	Chin.	{P.S., 0.00005 Q., 0.0015}	Nov. 20, 2.40 p. m.; Nov. 21, 22, 23, 24.	Nov. 20, 28; Dec. 1–4	Dec. 5, 7, 11–17.	Dec. 9	----------	Still alive.
		24	D13	Chin.	{P.S., 0.00005 Q., 0.0015}	Nov. 20, 2.40 p. m.; Nov. 21, 22, 23, 24.	Nov. 20, 28; Dec. 1	----------	----------	Dec. 2	

Nov. 20, 1931	C71	24	D14	Chin.	P.S., 0.00005 Q., 0.0015	Nov. 20, 2.45 p. m., Nov. 21, 22, 23, 24.	Nov. 20; Nov. 20,28; Dec. 1								Nov. 20 Dec. 1		
		24	D15	Chin.													
		24	D16	Chin.	P.S., 0.00005 Q., 0.0015	Nov. 20, 2.45 p. m., Nov. 21, 22, 23, 24.	Nov. 20	Nov. 20,28; Dec.1–21							Nov. 25		Still alive. Subsequently proved susceptible.
		24	D17	None.													
		24	D18	None.			Nov. 20,28; Dec. 1								Dec. 3		
		24	D19	None.			Nov. 20								Nov. 22		Do.
		24	D20	None.			Nov. 20,28; Dec.1–21										
		24	D21	None.			Nov. 20, 28		Dec. 1–4		Dec. 5				Dec. 10		
		24	D22	None.			Nov. 20								Nov. 22		

TABLE 12.—*Results of experiment 82 in which plasmochin simplex was added to sporozoites-saline mixtures in an attempt to prevent infections of P. capistrani in birds following injections of these mixtures.*

Date.	Mosquitoes infected.		Bird No.—	Control or experiment.	Results. Blood smears.			Died.	Remarks.
	From bird No.—	Days before experiment.			Negative.	+ ++	+++ ++++ +++++		
Jan. 23, 1932	D54 D56	25	J75	[a] E	Jan. 23, 29, 31; Feb. 2–18.			Apr. 10, 1932 (K)	Subsequently proved susceptible.
		25	J76	E	Jan. 23			Jan. 24, 1932	
		25	J77	E	Jan. 23, 29, 31	Feb. 2, 4, 6, 8, 11		Apr. 10, 1932 (K)	
		25	J78	E	Jan. 23			Jan. 25, 1932	
		25	J79	E	Jan. 23, 29, 31	Feb. 2, 4	Feb. 6, 8, 11	Feb. 15, 1932	
		25	D80	E	Jan. 23, 29, 31; Feb. 2–8.	Feb. 11–16		Feb. 17, 1932	
		25	J81	C	Jan. 23, 29, 31; Feb. 2.	Feb. 4	Feb. 6, 8, 11	Feb. 15, 1932	
		25	J82	C	Jan. 23			Jan. 23, 1932	
		25	J83	C	Jan. 23, 29, 31; Feb. 2.	Feb. 4, 6	Feb. 8, 11	Apr. 10, 1932 (K)	
		25	J84	C	Jan. 23, 29, 31	Feb. 2, 4, 8	Feb. 6	Apr. 10, 1932 (K)	
		25	J85	C	Jan. 23, 29, 31	Feb. 2, 4, 6, 11	Feb. 8	Apr. 10, 1932	
		25	J86	C	Jan. 23, 29	Jan. 31; Feb. 2, 4, 11.	Feb. 6, 8	Feb. 13, 1932	

[a] E, experiment bird; C, control bird, no drug; K, killed.

TABLE 13.—*Results of experiment 94 in which plasmochin simplex was added to blood-saline mixtures in an attempt to prevent infections of P. capistrani in birds following injections of these mixtures.*

Date.	Bird No.—	Experiment or control.	Results. Blood smears.			Died.	Remarks.
			Negative.	+ ++	+++ ++++ +++++		
April 16, 1932	C85	[a]C	Apr. 16, 22, 23	Apr. 25, 26			Still alive.
	S86	C	Apr. 16, 22	Apr. 23		Apr. 24, 1932	
	S87	C	Apr. 16, 22, 23	Apr. 25, 26			Do.
	S88	E	Apr. 16, 22, 23–30				Subsecuently proved susceptible.
	S89	E	Apr. 16, 22, 23–30				Do.
	S90	E	Apr. 16, 22, 23	Apr. 26, 27, 28, 29			Still alive.

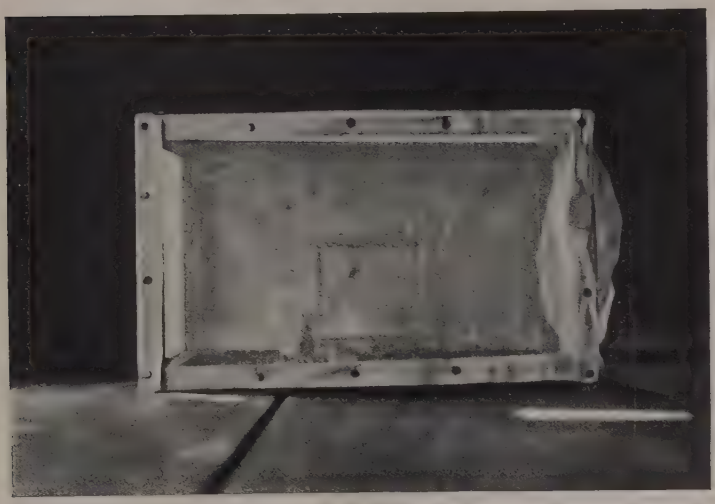
[a] C, control bird; E, experimental bird.

ILLUSTRATION

PLATE 1

FIG. 1. Mosquito and bird cages used in the experiment.
2. A bird cage inside a mosquito cage.

1



2

PLATE 1.

AVIAN MALARIA STUDIES, VIII

THE BLEEDING TIME IN CANARIES; NORMAL AND IN MALARIA[1]

By PAUL F. RUSSELL

Of the International Health Division of the Rockefeller Foundation

FIVE PLATES AND ONE TEXT FIGURE

INTRODUCTION

Duke(1, 2) first described the simple but informative bleeding-time test of the blood in man. His method and definition may best be given in his own words:

> Make a small cut in the lobe of the ear. At half minute intervals blot up on absorbent paper all the blood which has flowed out. This gives a series of blots. Each blot represents the volume of the blood flowing out in its respective half minute. From the rate of decrease in the size of the blots one can see at a glance the rate of decrease in the intensity of the hemorrhage. The duration of such a hemorrhage is called the bleeding time. On first thought one might believe that the bleeding time depends largely on the size of the cut. This, however, within certain limits, is not the case.

It must be emphasized that this bleeding time may or may not vary as the coagulation time. It is an independent test influenced, according to Kilduffe,(3) chiefly by (*a*) the thromboplastin content of the tissue juice, (*b*) the elasticity of the skin, and (*c*) the mechanical and chemical action of the blood plates. MacKay(4) holds that the most important factor in controlling the duration of bleeding time is not the number of blood platelets in circulation but the ability of the vessel wall to contract. As noted by Duke the size of the cut is not, within reason, a factor. It is usual, however, to make the cut of such a size that the first drop of blood when transferred to blotting paper will have a diameter of 1 to 2 centimeters.

[1] The experiments herein reported were done at the Bureau of Science, Manila, in the laboratory of malaria investigations, of which the author is chief and which is jointly supported by the Bureau of Science and the International Health Division of the Rockefeller Foundation. Mrs. I. Ramos, microscopist of malaria investigations, assisted in the experiments.

Not only is the bleeding time independent of the coagulation time, but it is said to be not greatly affected by anæmia and it is not prolonged in hæmophilia. Normally, in man, it is from one to four minutes, being somewhat longer in the first week of life. The bleeding time has been found to be prolonged from ten to ninety minutes or more in (*a*) cases of thrombopenia, as in purpura hæmorrhagica, and (*b*) in those conditions causing a reduced fibrinogen content of the blood, as in chloroform and phosphorus poisoning.

The normal platelet count in man is from 200,000 to 400,000 per cubic millimeter. When the platelets number more than 60,000 there is only a slight increase in the bleeding time. It is somewhat greater when there are between about 30,000 and 60,000 platelets and is very markedly greater when there are less than 30,000. In all such counts the coagulation time may be normal, but the clot retraction and the quality of the clot will be modified.

In 1921, I(5) examined a number of normal men and found their average bleeding time to be 2.5 minutes. The stab wound in the ear lobe in each case was made as nearly the same size as possible. In one individual the bleeding time was 2.5 minutes from a stab wound in the left ear lobe, but with a slightly deeper and longer incision in the right lobe it was 6 minutes. At the same time a patient (P. W.) with chronic purpura hæmorrhagica was under observation. In this case I found a bleeding time of 27 minutes and a platelet count of 16,000. This patient's blood clot was nonretracting in type, but the coagulation time was normal. There was no calcium deficiency.

The significance of a prolonged bleeding time in man is by no means clear and, it must be noted, it is still less evident in birds. In man it is believed by some that the hæmorrhage from a small stab wound in the skin is checked by the formation of platelet thrombi in the injured capillaries. When the platelets are reduced markedly these thrombi do not form with normal speed and the bleeding time is therefore prolonged. Since there is no reduction in numbers of platelets in hæmophilia the thrombi form at normal speed and there is no prolonged bleeding time. Coagulation time may not be affected coincidently with bleeding time because, although the platelets are reduced in number, there may still be plenty of prothrombin and fibrinogen to allow the normal reaction which results in fibrin and coagulation. But since the character of the clot depends apparently

on the numbers of formed elements in the blood, the clot will not be normal when the platelet count is low.

It may be worth while to recall that coagulation seems to depend on the formation of fibrin. This is formed apparently in two combinations, as follows: (*a*) Prothrombin + calcium salts = thrombin; (*b*) thrombin + fibrinogen = fibrin. A widely accepted theory of coagulation is still that of Howell,(6) as follows:

> In circulating blood we find as constant constituents fibrinogen, prothrombin, calcium salts and antithrombin. The last-named substance holds the prothrombin in combination and thus prevents its conversion or activation into thrombin.
>
> When blood is shed the disintegration of the blood platelets furnishes material (thromboplastin) which combines with the anti-thrombin and liberates the prothrombin; the latter is then activated by the calcium and acts on the fibrinogen.

Going back to the question of the bleeding time, according to Mallory and Wright(7) the situation is confused by the fact that coagulation and bleeding times may be prolonged in conditions in which there is no clearly demonstrable qualitative or quantitative alteration in the platelets. In some conditions there seems to be a positive correlation between lack of available calcium in the blood and a prolonged bleeding time, as for example, in certain types of jaundice. One of the best reviews of the subject of blood platelets is that of MacKay.(4)

BLEEDING TIME IN BIRDS

In discussing the bleeding time of birds it must be noted that according to most authorities birds have no blood platelets, an opinion to which I agree. Quoting Wright,(8)

> According to my own and others' observations, bodies that are undoubtedly and obviously blood plates are found only in the blood of mammals . . . The so-called spindle cell or fusiform corpuscles of the birds, amphibia, reptiles and fishes have been claimed by some writers to be the morphological equivalents of blood plates, but my studies of the blood of these vertebrates have not led me to accept this view.

These spindle cells, sometimes called hæmatoblasts or thrombocytes, may function similarly to the blood platelets of mammals, but they are certainly not homologous to them. They are more probably, as Wright(8) suggests, homologous to the mammalian megakaryocytes from which the blood platelets are believed to be detached.

The spindle cell of birds is about as long as a red cell but is narrower. The nucleus is round and nearly equal in diameter to the cell itself. The cytoplasm stains a faint purple and the nucleus a deeper shade of purple with Wright's or Giemsa's stain.

Normal fowl blood, according to Burnett,(9) Kaupp,(10) and Klieneberger(11) contains from 2,000,000 to over 4,000,000 red cells per cubic millimeter, from about 45,000 to 55,000 thrombocytes per cubic millimeter, and from about 18,000 to 30,000 leucocytes.

Ben-Harel(12) found the normal red-blood-cell count in canaries to be from 4,500,000 to 5,200,000 per cubic millimeter, the mean being about 4,500,000.

In a series of seventy-two red-cell counts in twenty-four normal canaries the average number of erythrocytes has been 3,350,000 per cubic millimeter. I have not found any reports of spindle-cell counts in canaries. In a series of counts in eight normal canaries we have found that on the average the thrombocytes are only 1.6 per cent as numerous as the erythrocytes. This would indicate normal counts of between 50,000 to 60,000 per cubic millimeter.

No reports of bleeding time in birds, normal or otherwise, have been found in a survey of this literature. It seemed worth while to find out whether or not any notable changes occur in the bleeding time of canaries during the course of malaria.

PROCEDURE

The birds used in these experiments were canaries (*Serinus canarius*.) The parasite was *Plasmodium cathemerium* Hartman, 1927. Infections were produced in the usual way by intramuscular injections of blood from birds known to be infective.

To obtain the bleeding time the procedure was essentially that of Duke(1, 2) as outlined above. Blood was taken from uniform punctures made with a Hagedorn needle on the inner side of the legs of the birds. The rate of flow of blood in birds is much higher than in man and the bleeding time much shorter. Therefore, the intervals between blotting in these experiments were only ten instead of thirty seconds. One assistant marked time while the other applied the absorbent paper. All of the tests reported in this paper were done by the same microscopist, using the same technic in the same way. They are strictly comparable in this sense. (See illustrations.)

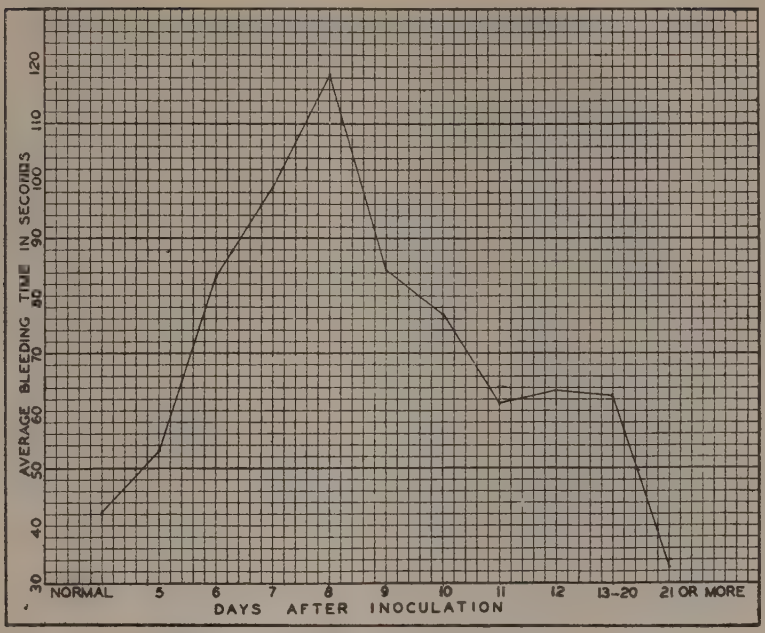


FIG. 1. Average bleeding time in seconds in groups of birds, normal and at varying periods after inoculations. (See Tables 1 to 11.)

TABLE 1.—*Bleeding time in normal birds (before inoculation with malaria).*

[Average time 42.4 ± 10.4 seconds, in 180 tests.]

Bird No.	Bleeding time.		Bird No.	Bleeding time.		Bird No.	Bleeding time.	
	Date.	Seconds.		Date.	Seconds.		Date.	Seconds.
	1931			1931			1931	
----------	May 18	50	----------	May 18	70	----------	May 18	40
----------	May 18	60	----------	May 18	40	----------	May 18	30
----------	May 18	50	----------	May 18	30	----------	May 18	40
----------	May 18	50	----------	May 18	30	----------	May 18	40
----------	May 18	70	----------	May 18	20	----------	May 18	30
----------	May 18	60	----------	May 18	60	----------	May 18	30
----------	May 18	50	----------	May 18	50	----------	May 18	50
----------	May 18	50	----------	May 18	40	----------	May 18	50
----------	May 18	60	----------	May 18	20	----------	May 18	30
----------	May 18	50	----------	May 18	20	----------	May 18	50
----------	May 18	40	----------	May 18	20	----------	May 18	20
----------	May 18	40	----------	May 18	40	----------	May 18	40
----------	May 18	50	----------	May 18	50	----------	May 18	40
----------	May 18	30	----------	May 18	50	----------	May 18	30
----------	May 18	30	----------	May 18	30	----------	May 18	30
----------	May 18	30	----------	May 18	70	----------	May 18	20
----------	May 18	40	----------	May 18	40	----------	May 18	30

TABLE 1.—*Bleeding time in normal birds (before inoculation with malaria)*—Continued.

Bird No.	Bleeding time.		Bird No.	Bleeding time.		Bird No.	Bleeding time.	
	Date.	Seconds.		Date.	Seconds.		Date.	Seconds.
	1931			1931			1932	
----------	May 18	60	N48	Aug. 9	60	S17	Jan. 2	40
----------	May 18	50	N49	Aug. 9	70	S18	Jan. 2	40
----------	May 18	40	N62	Aug. 19	40	S19	Jan. 2	50
----------	May 18	40	N63	Aug. 19	60	S20	Jan 2	40
N10	June 26	40	N64	Aug. 19	40	S21	Jan. 2	60
N11	June 26	80	N65	Aug. 19	40	S22	Jan. 2	40
N12	June 26	40	N66	Aug. 19	50	S23	Jan. 2	40
N13	June 26	60	N67	Aug. 19	70	S16	Jan. 18	30
N14	June 26	50	N68	Aug. 24	50	S17	Jan. 18	50
N15	June 26	40	N69	Aug. 24	20	S18	Jan. 18	40
N10	June 27	20	N70	Aug. 24	40	S19	Jan. 18	30
N11	June 27	40	N71	Aug. 24	40	S20	Jan. 18	30
N12	June 27	30	N72	Aug. 24	30	S21	Jan. 18	40
N13	June 27	50	N80	Oct. 16	60	S22	Jan. 18	40
N14	June 27	30	N81	Oct. 16	60	S23	Jan. 18	50
N15	June 27	40	N82	Oct. 16	30	S24	Jan. 22	40
N16	July 3	40	N83	Oct. 16	40	S25	Jan. 22	60
N17	July 3	50	N84	Oct. 16	50	S26	Jan. 22	60
N18	July 3	40	N85	Oct. 16	50	S27	Jan. 22	40
N19	July 3	20	N86	Oct. 16	50	S22	Feb. 4	50
N20	July 3	50	N87	Oct. 16	50	S23	Feb. 4	50
N21	July 3	30	N88	Oct. 16	40	S22	Feb. 5	70
N16	July 4	40	N89	Oct. 16	60	S23	Feb. 5	60
N17	July 4	30	N90	Oct. 16	60	S22	Feb. 6	60
N18	July 4	20	N91	Oct. 16	60	S23	Feb. 6	50
N19	July 4	30	N53	Nov. 3	40	S22	Feb. 8	50
N20	July 4	40	N55	Nov. 3	30	S23	Feb. 8	40
N21	July 4	20	N56	Nov. 3	40	S22	Feb. 9	30
N28	July 23	40	N57	Nov. 3	40	S23	Feb. 9	30
N29	July 23	20	Y28	Sept. 2	40	S22	Feb. 10	40
N30	July 23	60	Y29	Sept. 2	30	S23	Feb. 10	40
N31	July 23	30	Y30	Sept. 2	30	S23	Feb. 13	30
N32	July 23	30	Y31	Sept. 2	50	S20	Jan. 12	70
N33	July 23	20	Y33	Sept. 2	40	S23	Jan. 12	40
N40	Aug. 4	30	Y 3	Oct. 13	20	S20	Jan. 12	30
N41	Aug. 4	40	Y65	Oct. 26	40	S23	Jan. 12	70
N42	Aug. 4	50	Y66	Oct. 26	30	S16	Jan. 16	40
N43	Aug. 4	40	Y67	Oct. 26	40	S17	Jan. 16	40
N44	Aug. 4	40	Y68	Oct. 26	30	S19	Jan. 16	30
N45	Aug. 4	60	Y63	Oct. 26	40	S20	Jan. 16	40
N50	Aug. 7	40	Y64	Oct. 26	60	S21	Jan. 16	50
N51	Aug. 7	30		1932		S22	Jan. 16	50
N52	Aug. 7	70	S15	Jan. 2	30	S23	Jan. 16	30
N47	Aug. 9	70	S16	Jan. 2	30			

[a] 10.50 a. m. [b] 8.45 a. m.

TABLE 2.—*Bleeding time in avian malaria five days after inoculation.*

[Average time 53.6 seconds, in 11 tests.]

Bird No.	Date of bleeding.	Bleeding time.	Blood smear on bleeding time date.	Date of inoculation.
		Sec.		
N-53	Nov. 9, 1931	40	0	Nov. 4
N-55	Nov. 9, 1931	130	0	Nov. 4
N-56	Nov. 9, 1931	50	0	Nov. 4
N-57	Nov. 9, 1931	40	0	Nov. 4
N-58	Nov. 9, 1931	40	0	Nov. 4
Y-47	Sept. 22, 1931	60	+	Sept. 17
Y-48	Sept. 22, 1931	70	+	Sept. 17
Y-49	Sept. 22, 1931	50	++	Sept. 17
Y-51	Sept. 22, 1931	30	+	Sept. 17
S-20	Feb. 4, 1932	40	+	Jan. 30
S-21	Feb. 4, 1932	40	+	Jan. 30

TABLE 3.—*Bleeding time in acute avian malaria six days after inoculation.*

[Average time 83.9 seconds, in 28 tests.]

Bird No.	Date of bleeding.	Bleeding time.	Blood smear on bleeding time date.	Date of inoculation.
		Sec.		
L-94	June 19, 1931	60	+	June 13
L-97	June 19, 1931	60	+	June 13
L-96	June 19, 1931	40	+	June 13
L-96	June 19, 1931	60	+	June 13
L-91	June 16, 1931	170	0	June 10
L-87	June 16, 1931	160	0	June 10
N-16	July 12, 1931	100	++	July 6
N-17	July 12, 1931	70	++++	July 6
N-18	July 12, 1931	100	++	July 6
N-19	July 12, 1931	70	++++	July 6
N-21	July 12, 1931	60	+	July 6
N-62	Aug. 27, 1931	100	+	Aug. 21
N-63	Aug. 27, 1931	70	+	Aug. 21
N-64	Aug. 27, 1931	80	+	Aug. 21
N-65	Aug. 27, 1931	70	+++++	Aug. 21
N-66	Aug. 27, 1931	90	++++	Aug. 21
N-67	Aug. 27, 1931	120	++	Aug. 21
Y-35	Sept. 18, 1931	80	++++	Sept. 12
Y-41	Sept. 18, 1931	100	+	Sept. 12
Y-42	Sept. 18, 1931	140	++	Sept. 12
Y-44	Sept. 18, 1931	80	+	Sept. 12
Y-64	Nov. 2, 1931	70	+	Oct. 27
Y-65	Nov. 2, 1931	40	+	Oct. 27
Y-66	Nov. 2, 1931	100	+	Oct. 27
Y-67	Nov. 2, 1931	80	+	Oct. 27
Y-68	Nov. 2, 1931	90	+	Oct. 27
S-20	Feb. 5, 1932	40	+	Jan. 30
S-21	Feb. 5, 1932	50	+	Jan. 30

TABLE 4.—*Bleeding time in acute avian malaria seven days after inoculation.*

[Average time 98.9 seconds, in 18 tests.]

Bird No.	Date of bleeding.	Bleeding time.	Blood smear on bleeding time date.	Date of inoculation.
		Sec.		
N-10	July 6, 1931	100	++	June 29
N-11	July 6, 1931	120	++	June 29
N-12	July 6, 1931	180	++++	June 29
N-14	July 6, 1931	140	++++	June 29
N-15	July 6, 1931	90	++++	June 29
N-19	July 13, 1931	90	+++++	July 6
N-21	July 13, 1931	90	++++	July 6
N-16	July 13, 1931	230	++++	July 6
N-17	July 13, 1931	100	+++++	July 6
N-18	July 13, 1931	210	++++	July 6
N-40	Aug. 14, 1931	80	+++	Aug. 7
N-41	Aug. 14, 1931	50	++++	Aug. 7
N-42	Aug. 14, 1931	130	+++++	Aug. 7
S-16	Jan. 25, 1932	30	0	Jan. 18
S-17	Jan. 25, 1932	30	+	Jan. 18
S-18	Jan. 25, 1932	30	+	Jan. 18
S-20	Feb. 6, 1932	40	+	Jan. 30
S-21	Feb. 6, 1932	40	+	Jan. 30

TABLE 5.—*Bleeding time in acute avian malaria eight days after inoculation.*

[Average time 118.6 seconds, in 21 tests.]

Bird No.	Date of bleeding.	Bleeding time.	Blood smear on bleeding time date.	Date of inoculation.
		Sec.		
L-48	May 19, 1931	70	+	May 11
N-10	July 7, 1931	110	+++	June 29
N-11	July 7, 1931	290	++	June 29
N-12	July 7, 1931	90	+++	June 29
N-14	July 7, 1931	360	++++	June 29
N-15	July 7, 1931	100	++++	June 29
N-43	Aug. 15, 1931	170	++++	Aug. 7
N-46	Aug. 15, 1931	150	++++	Aug. 7
N-47	Aug. 18, 1931	80	+++++	Aug. 10
N-48	Aug. 18, 1931	140	+++++	Aug. 10
N-49	Aug. 18, 1931	70	+++++	Aug. 10
N-50	Aug. 18, 1931	110	+++++	Aug. 10
N-51	Aug. 18, 1931	150	+++++	Aug. 10
N-52	Aug. 18, 1931	100	++	Aug. 10
Y-28	Sept. 15, 1931	80	+++++	Sept. 7
Y-29	Sept. 15, 1931	30	++++	Sept. 7
Y-30	Sept. 15, 1931	70	0	Sept. 7
Y-33	Sept. 15, 1931	130	+++++	Sept. 7
S-16	Jan. 26, 1932	70	+	Jan. 18
S-17	Jan. 26, 1932	60	+	Jan. 18
S-18	Jan. 26, 1932	60	+	Jan. 18

TABLE 6.—*Bleeding time in acute avian malaria nine days after inoculation.*

[Average time 84.4 seconds, in 18 tests.]

Bird No.	Date of bleeding.	Bleeding time.	Blood smear on bleeding time date.	Date of inoculation.
		Sec.		
L–46	May 20, 1931	90	+	May 11
L–48	May 20, 1931	100	+	May 11
L–89	June 19, 1931	100	+++	June 10
L–92	June 19, 1931	90	++++	June 10
L–93	June 19, 1931	90	+	June 10
L–90	June 19, 1931	100	++++	June 10
N– 1	June 26, 1931	70	+++++	June 17
N– 2	June 26, 1931	110	++++	June 17
N–15	July 8, 1931	60	+++++	June 29
N–29	Aug. 3, 1931	140	+++	July 25
N–31	Aug. 3, 1931	60	+++++	July 25
N–33	Aug. 3, 1931	60	+++++	July 25
D–87	Jan. 8, 1932	50	+	Dec. 30
S–16	Jan. 27, 1932	80	+	Jan. 18
S–17	Jan. 27, 1932	50	+	Jan. 18
S–18	Jan. 27, 1932	110	++	Jan. 18
S–20	Feb. 8, 1932	120	++++	Jan. 30
S–21	Feb. 8, 1932	40	+++++	Jan. 30

RESULTS

In a series of one hundred eighty tests in normal birds the average bleeding time was found to be 42.4 ± 10 seconds and this may be taken as the usual bleeding time in canaries. (See Table 1.)

TABLE 7.—*Bleeding time in acute avian malaria ten days after inoculation.*

[Average time 76.4 seconds, in 28 tests.]

Bird No.	Date of bleeding.	Bleeding time.	Blood smear on bleeding time date.	Date of inoculation.
		Sec.		
L-48	May 21, 1931	150	+	May 11
N-15	July 9, 1931	40	+++++	June 29
N-40	Aug. 17, 1931	110	+++++	Aug. 7
N-41	Aug. 17, 1931	150	+++++	Aug. 7
N-43	Aug. 17, 1931	60	+++++	Aug. 7
N-46	Aug. 17, 1931	60	+++++	Aug. 7
N-80	Oct. 27, 1931	50	+	Oct. 17
N-82	Oct. 27, 1931	30	+	Oct. 17
N-83	Oct. 27, 1931	100	+	Oct. 17
N-86	Oct. 27, 1931	120	+	Oct. 17
N-89	Oct. 27, 1931	70	+	Oct. 17
N-90	Oct. 27, 1931	90	+	Oct. 17
N-91	Oct. 27, 1931	110	+	Oct. 17
Y-16	Aug. 27, 1931	90	++	Aug. 17
Y-20	Aug. 27, 1931	110	++++	Aug. 17
Y-23	Aug. 27, 1931	80	+	Aug. 17
Y-24	Aug. 27, 1931	90	+	Aug. 17
Y-25	Aug. 27, 1931	90	+	Aug. 17
Y-35	Sept. 22, 1931	30	+	Sept. 12
Y-41	Sept. 22, 1931	40	+	Sept. 12
Y-42	Sept. 22, 1931	50	++	Sept 12
Y-44	Sept. 22, 1931	90	+	Sept. 12
Y-46	Sept. 22, 1931	50	0	Sept. 12
S-16	Jan. 28, 1932	40	+	Jan. 18
S-17	Jan. 28, 1932	60	++	Jan. 18
S-18	Jan. 28, 1932	60	++++	Jan. 18
S-20	Feb. 9, 1932	70	+++++	Jan. 30
S-21	Feb. 9, 1932	50	+++++	Jan. 30

TABLE 8.—*Bleeding time in acute avian malaria eleven days after inoculation.*

[Average time 61.8 seconds, in 17 tests.]

Bird No.	Date of bleeding.	Bleeding time.	Blood smear on bleeding time date.	Date of inoculation.
		Sec.		
L-40	May 19, 1931	60	+	May 8
L-54	May 29, 1931	60	++++	May 18
L-57	May 29, 1931	60	++++	May 18
L-52	May 29, 1931	100	+++++	May 18
L-56	May 29, 1931	50	+	May 18
L-55	May 29, 1931	40	++++	May 18
L-53	May 29, 1931	60	++++	May 18
N-15	July 10, 1931	20	+++++	June 29
N-17	July 17, 1931	50	+++++	July 6
Y-29	Sept. 18, 1931	50	+++++	Sept. 7
Y-30	Sept. 18, 1931	150	0	Sept. 7
Y-33	Sept. 18, 1931	20	+++++	Sept. 7
S-16	Jan. 29, 1932	30	++	Jan. 18
S-17	Jan. 29, 1932	70	+++	Jan. 18
S-18	Jan. 29, 1932	60	+++++	Jan. 18
S-20	Feb. 10, 1932	110	++++	Jan. 30
S-21	Feb. 10, 1932	60	+++++	Jan. 30

TABLE 9.—*Bleeding time in acute avian malaria twelve days after inoculation.*

[Average time 68 seconds, in 10 tests.]

Bird No.	Date of bleeding.	Bleeding time.	Blood smear or bleeding time date.	Date of inoculation.
		Sec.		
L-42	May 20, 1931	70	+++	May 8
L-59	Aug. 26, 1931	60	++++	Aug. 14
L-59	Aug. 26, 1931	120	++++	Aug. 14
N-15	July 11, 1931	50	+++++	June 29
N-17	July 18, 1931	40	+++++	July 6
X-66	Aug. 26, 1931	50	++++	Aug. 14
X-99	Aug. 26, 1931	90	+++	Aug. 14
X-66	Aug. 26, 1931	40	++++	Aug. 14
X-99	Aug. 26, 1931	70	+++	Aug. 14
S-16	Jan. 30, 1932	50	+++++	Jan. 18

TABLE 10.—*Bleeding time in subacute avian malaria thirteen to twenty days after inoculation.*

[Average time 62.9 seconds, in 35 tests.]

Bird No.	Date of bleeding.	Bleeding time.	Blood smear on bleeding time date.	Inoculation.	Days from inoculation to bleeding date.
		Sec.			
L-35	May 18, 1931	60	+	May 4	14
L-39	May 18, 1931	30	++	May 4	14
L-37	May 18, 1931	30	+	May 4	14
L-35	May 19, 1931	60	+	May 4	15
L-36	May 19, 1931	50	++	May 4	15
L-39	May 19, 1931	40	++	May 4	15
L-37	May 19, 1931	50	+	May 4	15
L-36	May 21, 1931	50	+++	May 4	17
L-40	May 21, 1931	50	+	May 8	13
L-50	May 29, 1931	60	++++	May 15	14
L-46	May 29, 1931	60	+++++	May 11	18
L-46	May 29, 1931	70	+++++	May 11	18
L-83	June 19, 1931	70	+++++	June 6	13
L-84	June 19, 1931	80	+	June 6	13
N-17	July 19, 1931	70	+++++	July 6	13
N-17	July 20, 1931	60	+++++	July 6	14
N-21	July 21, 1931	50	+++++	July 6	15
N-80	Oct. 31, 1931	70	++++	Oct. 17	14
N-82	Oct. 31, 1931	70	++++	Oct. 17	14
N-83	Oct. 31, 1931	50	+++++	Oct. 17	14
N-85	Oct. 31, 1931	100	0	Oct. 17	14
N-89	Oct. 31, 1931	50	+++++	Oct. 17	14
N-90	Oct. 31, 1931	100	++++	Oct. 17	14
N-91	Oct. 31, 1931	90	+++++	Oct. 17	14
Y-16	Sept. 3, 1931	40	++	Aug. 17	17
Y-19	Sept. 3, 1931	70	+++++	Aug. 17	17
Y-22	Sept. 3, 1931	40	+	Aug. 17	17
Y-23	Sept. 3, 1931	20	++	Aug. 17	17
Y-24	Sept. 4, 1931	110	++++	Aug. 17	18
Y-25	Sept. 4, 1931	50	0	Aug. 17	18
D-71	Jan 8, 1932	60	++++	Dec. 22	17
D-72	Jan. 8, 1932	90	++++	Dec. 22	17
D-74	Jan. 8, 1932	130	+++++	Dec. 22	17
S-20	Feb. 13, 1932	40	+	Jan. 30	14
S-21	Feb. 13, 1932	80	+++	Jan. 30	14

TABLE 11.—*Bleeding time in chronic avian malaria twenty-one or more days after inoculation.*

[Average time 32.7 seconds, in 113 tests.]

Bird No.	Date of bleeding.	Bleeding time.	Blood smear or bleeding time date.	Inoculation.	Days from inoculation to bleeding date.
		Sec.			
L–20	May 18, 1931	40	+	April 25	23
L–22	May 18, 1931	40	+	April 25	23
L–22	May 19, 1931	50	+	April 25	24
L–21	May 19, 1931	120	+	April 25	24
L–25	May 19, 1931	70	+	April 28	21
L–21	May 20, 1931	60	+	April 25	25
L–14	June 17, 1931	30	0	April 20	58
L–9	June 17, 1931	30	0	April 13	65
L–25	June 17, 1931	40	0	April 2	76
L–39	June 17, 1931	30	0	May 4	44
L–11	June 17, 1931	60	0	April 18	60
L–50	June 17, 1931	20	0	May 15	33
L–20	June 17, 1931	20	+	April 25	53
L–27	June 17, 1931	30	0	April 28	50
L–22	June 17, 1931	30	+	April 25	53
L–58	June 17, 1931	30	0	May 14	34
L–20	June 17, 1931	20	+	April 25	53
L–14	Aug. 20, 1931	40	0	April 20	122
L–25	Aug. 20, 1931	20	0	April 28	114
L–27	Aug. 20, 1931	30	0	April 28	114
L–35	Aug. 20, 1931	30	0	May 4	108
L–40	Aug. 20, 1931	20	0	May 4	108
L–48	Aug. 20, 1931	30	0	May 11	101
L–14	Sept. 15, 1931	30	0	April 20	148
L–22	Sept. 15, 1931	20	0	April 25	143
L–25	Sept. 15, 1931	20	0	April 28	140
L–27	Sept. 15, 1931	40	0	April 28	140
L–35	Sept. 15, 1931	40	0	May 4	134
L–39	Sept. 15, 1931	30	0	May 4	134
L–40	Sept. 15, 1931	30	0	May 8	130
L–48	Sept. 15, 1931	30	0	May 11	127
L–57	Sept. 15, 1931	20	0	May 18	120
L–76	Sept. 15, 1931	30	0	June 1	106
L–92	Sept. 15, 1931	40	0	June 10	97
L–94	Sept. 15, 1931	30	0	June 13	94
J–16	May 29, 1931	40	0	Aug. 26, 1930	276
J–54	May 29, 1931	50	0	Nov. 15, 1930	195
J–44	May 29, 1931	30	0	Sept. 13, 1930	254
J–52	May 29, 1931	50	0	Nov. 1, 1930	209
J–51	May 29, 1931	30	0	Nov. 1, 1930	209
J–21	May 29, 1931	50	0	Aug. 27, 1930	275
J–27	May 29, 1931	30	0	Aug. 29, 1930	273
J–50	May 29, 1931	20	0	Oct. 14, 1930	227
J–42	May 29, 1931	30	0	Sept. 15, 1930	256
J–46	May 29, 1931	30	0	Oct. 2, 1930	239
J–28	May 29, 1931	40	0	Aug. 29, 1930	273
J–49	May 29, 1931	30	0	Oct. 14, 1930	227
J–51	May 29, 1931	60	0	Nov. 1, 1930	209

TABLE 11.—*Bleeding time in chronic avian malaria twenty-one or more days after inoculation*—Continued.

Bird No.	Date of bleeding.	Bleeding time.	Blood smear or bleeding time date.	Inoculation.	Days from inoculation to bleeding date.
		Sec.			
J-27	May 29, 1931	30	0	Aug. 27, 1930	275
J-50	May 29, 1931	20	0	Oct. 14, 1930	227
J-42	May 29, 1931	30	0	Sept. 15, 1930	256
J-46	May 29, 1931	30	0	Oct. 2, 1930	239
N-73	Nov. 3, 1931	30	0	September 23	42
N-74	Nov 3, 1931	50	0	September 23	42
N-75	Nov. 3, 1931	70	0	September 23	42
N-76	Nov. 3, 1931	70	0	September 23	42
N-73	Nov. 9, 1931	40	0	September 23	47
N-74	Nov. 9, 1931	80	0	September 23	47
N-48	Oct. 15, 1931	90	0	August 10	66
N-60	Oct. 15, 1931	90	+	August 14	62
N-61	Oct. 15, 1931	100	0	August 20	56
Y-11	Oct. 13, 1931	30	0	August 28	46
Y-12	Oct. 13, 1931	30	+	August 28	46
Y-14	Oct. 13, 1931	40	0	August 25	49
Y-16	Oct. 13, 1931	40	0	August 17	57
Y-22	Oct. 13, 1931	30	+	August 17	57
Y-23	Oct. 13, 1931	40	+	August 17	57
Y-24	Oct. 13, 1931	40	0	August 17	57
Y-25	Oct. 13, 1931	40	+	August 17	57
Y-35	Oct. 13, 1931	30	+	September 12	31
Y-41	Oct. 13, 1931	40	0	September 12	31
Y-42	Oct. 13, 1931	40	0	September 12	31
Y-44	Oct. 15, 1931	50	0	September 12	33
Y-48	Oct. 15, 1931	20	0	September 17	28
Y-49	Oct. 15, 1931	30	+	September 17	28
Y-51	Oct. 15, 1931	50	+	September 17	28
Y-57	Oct. 15, 1931	20	+++++	September 22	23
Y-58	Oct. 15, 1931	40	+	September 22	23
Y-59	Oct. 15, 1931	30	+	September 22	23
Y-70	Oct. 26, 1931	60	0	September 22	34
Y-72	Oct. 26, 1931	40	0	September 22	34
Y-46	Oct. 26, 1931	80	0	September 12	44
Y-60	Oct. 26, 1931	30	0	September 5	41
Y-61	Oct. 26, 1931	50	0	September 5	41
Y-73	Oct. 26, 1931	50	0	September 22	34
Y-74	Oct. 26, 1931	60	0	September 22	34
Y-76	Oct. 26, 1931	70	0	September 22	34
Y-77	Oct. 30, 1931	50	0	September 22	38
Y-79	Oct. 30, 1931	20	0	September 22	38
Y-80	Oct. 30, 1931	40	0	September 22	38
Y-60	Nov. 2, 1931	50	+	September 5	58
Y-61	Nov. 2, 1931	50	+	September 5	58
Y-70	Nov. 2, 1931	50	+	September 22	41
Y-72	Nov. 2, 1931	60	+	September 22	41
Y-73	Nov. 2, 1931	60	++	September 22	41
Y-74	Nov. 2, 1931	70	+	September 22	41
Y-76	Nov. 2, 1931	40	+	September 22	41
Y-77	Nov. 4, 1931	50	0	September 22	41

TABLE 11.—*Bleeding time in chronic avian malaria twenty-one or more days after inoculation*—Continued.

Bird No.	Date of bleeding.	Bleeding time.	Blood smear or bleeding time date.	Inoculation.	Days from inoculation to bleeding date.
		Sec.			
Y-79	Nov. 4, 1931	40	0	September 22	41
Y-80	Nov. 4, 1931	50	0	September 22	41
Y-77	Nov. 7, 1931	70	+	September 22	46
Y-79	Nov. 7, 1931	70	+	September 22	46
Y-80	Nov. 7, 1931	60	+	September 22	46
D-34	Jan. 8, 1932	40	+	December 3	36
V-100	June 17, 1931	40	0	Sept. 24, 1930	266
V-97	June 17, 1931	30		Sept. 1, 1930	289
V-41	May 29, 1931	40		July 12, 1930	321
V-41	May 29, 1931	30		July 12, 1930	321
V-49	May 29, 1931	40		July 18, 1930	315
V-100	May 29, 1931	30		July 18, 1930	315
V-95	June 17, 1931	50	0	Sept. 24, 1930	266
V-41	June 17, 1931	40		July 12, 1930	340
V-81	June 3, 1931	30		Aug. 11, 1930	310

A series of two hundred ninety-five tests were made in birds having malaria. These tests have been divided, as shown in Tables 2 to 11, into groups with bleeding times as follows:

Day following inoculation that bird was bled.	Average bleeding time. Sec.
Fifth	53.6
Sixth	83.9
Seventh	98.9
Eighth	118.6
Ninth	84.4
Tenth	76.4
Eleventh	61.8
Twelveth	64.0
Thirteenth	52.9
Twenty-first or later (See graph)	32.7

These tests may also be grouped more generally as in Table 12.

TABLE 12.—*Bleeding time grouped according to status of the infection with normal figure for comparison.*

Status of infection.	Days after inoculation.	Number of tests.	Total bleeding time.	Average bleeding time.
			Sec.	*Sec.*
Normal bird, not infected		180	7,630	42.4 (+10.4)
Acute	5–8	78	7,210	92.4
Subacute	9–20	104	7,550	72.6
Chronic	21 or more	113	3,700	32.7

TABLE 13.—*Bleeding times before and after inoculation. Avian malaria.*

Bird No.	Bleeding time before inoculation.			Bleeding times in seconds grouped by number of days after inoculation.								
	First reading.	Second reading.	Average.	6	7	8	9	10	11	12	13	14
N-10	40	20	30		100	110						
N-11	80	40	60		120	290						
N-12	40	30	35		180	90						
N-13	60	50	55									
N-14	50	30	40		140	360						
N-15	40	40	40		90	100	60	40	20	50		
N-16	40	40	40	100	230							
N-17	50	30	40	70	100				50	40	70	[a]60
N-18	40	20	30	100	210							
N-19	20	30	25	70	90							
N-20	50	40	45									
N-21	30	20	25	60	90							
N-29	20		20				140					
N-31	30		30				60					
N-33	20		20				60					
N-40	30		30		80			110				
N-41	40		40		50			150				
N-42	50		50		130							
N-43	40		40			170		60				
N-46	40		40			150		60				
N-47	70		70			80						
N-48	60		60			140						
N-49	70		70			70						
N-50	40		40			110						
N-51	30		30			150						
N-52	70		70			100						
N-62	40		40	100								
N-63	60		60	70								
N-64	40		40	80								
N-65	40		40	70								
N-66	50		50	90								
N-67	70		70	120								
N-80	60		60					50				70
N-82	30		30					30				70
N-83	40		40					100				50
N-85	50		50									100
N-86	50		50					120				
N-89	60		60					70				50
N-90	60		60					90				100
N-91	60		60					110				90
Total			1,785	930	1,610	1,920		990				590
Average			44.6	84.5	123.8	147.7		82.5				73.8

[a] On the fifteenth day the bleeding time was fifty seconds.

In forty cases birds which were bled before inoculation were also bled again one or more times after inoculation. The results in these cases have been grouped in Table 13. It is again

evident that there is a rise in the curve of the bleeding time in acute malaria from a normal of approximately forty to fifty seconds to a high on the eighth day of two minutes or more, after which the bleeding time tends to become shorter. These results in Table 13 may also be grouped as in Table 14:

TABLE 14.—*Bleeding times taken before and after inoculation. Avian malaria.*

Status of infection.	Days after inoculation	Number of tests.	Total of bleeding time.	Average bleeding time.
			Sec.	*Sec.*
Normal bird, not infected		40	1,785	44.6
Acute	5– 8	37	4,460	120.5
Subacute	9–20	30	2,180	72.7

Table 14 resembles Table 12 in the same way that Table 13 gives similar results to those in Tables 2 to 11.

In fifty-seven instances on the same morning that bleeding times were taken a red-blood-cell count was made. The results of these tests are shown in Table 15. Generally speaking it appears that the shorter the bleeding time the higher the red-blood-cell count and vice versa.

We may also group these results more generally as in Table 16.

There are too few tests in the subacute and chronic groups to permit any conclusions. But with twenty eight birds counted in the normal group it is likely that the normal red-cell count for canaries purchased in Manila is about 3,350,000. The birds as a rule are somewhat undernourished at first, so that this count may be slightly lower than normal. The pipettes were calibrated and all counts were done by one microscopist.

There is a decrease in red cells in malaria and this decrease coincides with the increased bleeding time but is not necessarily a cause of that increase.

An attempt was made to get some information regarding the calcium content of the blood at the same time the bleeding time was being measured. In Tables 17 and 18 are given some results which must be regarded as preliminary in view of the small amount of blood, usually not more than 0.5 cubic centimeter, available for testing. I am indebted to Maj. Rufus L. Holt, of the Medical Department Research Board, United States Army, at the Bureau of Science, for the calcium determinations.

TABLE 15.—*Bleeding times and red-blood-cell counts determined in the same birds at the same time.*

Bleeding time, 10 to 30 seconds.			Bleeding time, 40 to 60 seconds.			Bleeding time, 70 to 110 seconds.		
Bird.	Date.	[a] R. B. C.	Bird.	Date.	[a] R. B. C.	Bird.	Date.	[a] R. B. C.
	1931			1931			1931	
N29	July 23	366	N45	Aug. 4	340	N47	Aug. 18	154
N31	July 23	353	N50	Aug. 7	388	N49	Aug. 18	137
N32	July 23	394	N48	Aug. 9	298	N50	Aug. 18	133
N33	July 23	381	N41	Aug. 14	156	N52	Aug. 18	167
N40	Aug. 4	363	N43	Aug. 17	141	N67	Aug. 19	362
N51	Aug. 7	290	N46	Aug. 17	172	N62	Aug. 27	164
N69	Aug. 24	289	N62	Aug. 19	310	N63	Aug. 27	183
N72	Aug. 24	239	N63	Aug. 19	329	N64	Aug. 27	129
L14	Sept. 15	395	N64	Aug. 19	182	N65	Aug. 27	151
L22	Sept. 15	454	N65	Aug. 19	267	N66	Aug. 27	212
L25	Sept. 15	285	N66	Aug. 19	245	Total		3,269
L57	Sept. 15	264	N68	Aug. 24	385	Average		218
Total		4,073	N71	Aug. 24	184			
Average		339	L27	Sept. 15	311	Bleeding time, 120 or more seconds.		
			L92	Sept. 15	422			
Bleeding time, 40 to 60 seconds.			Total		6,733			
			Average		293	N29	Aug. 3	184
						N42	Aug. 14	155
N28	July 23	361	Bleeding time, 70 to 110 seconds.			N43	Aug. 15	147
N30	July 23	387				N46	Aug. 15	175
N31	Aug. 3	172				N41	Aug. 17	142
N33	Aug. 3	116	N52	Aug. 7	278	N48	Aug. 18	173
N41	Aug. 4	374	N47	Aug. 9	370	N67	Aug. 27	171
N42	Aug. 4	348	N49	Aug. 9	353	Total		1,147
N43	Aug. 4	405	N40	Aug. 14	250	Average		164
N44	Aug. 4	450	N40	Aug. 17	226			

[a] "R. B. C." means red blood cells per cubic millimeter. Four ciphers have been omitted after each of the numbers in this column.

TABLE 16.—*Average bleeding times and red-blood-cell counts in same birds grouped according to status of infection.*

Status of infection.	Days after inoculation.	Number of tests.	Total of bleeding time.	Average red blood-cell count per cubic millimeter.
			Sec.	
Normal bird		28	44.3	3,350,000
Acute	5–8	16	100.6	1,660,000
Subacute	9–20	7	91.4	1,650,000
Chronic	21 or more	6	28.3	3,550,000

TABLE 17.—*Calcium determination in avian malaria grouped according to status of infection, with normal figures for comparison.*

Status of infection.	Days after inoculation.	Number of tests.	Average calcium content in 100 cubic centimeters blood.
			Mg.
Normal birds		52	11.1
Acute	5– 8	26	8.0
Subacute	9–20	25	9.5
Chronic	21 or more.	56	12.5

TABLE 18.—*Calcium determination and bleeding time in avian malaria.*

Bleeding time.	Calcium determinations.		
	Number.	Total.	Average content of 100 cubic centimeters blood.
Sec			*Mg.*
10–30	36	433.67	12.05
40–60	75	805.59	12.74
70–110	44	476.35	10.83
120 or more	9	70.65	7.85

No attempt is made at this time to explain the interesting fact that the bleeding time in acute avian malaria is in many cases considerably longer than normal. It is believed that the method of determining this time is a good one since in one hundred eighty tests on normal birds the standard deviation was only 10 seconds in respect to an average of 42.4 seconds, with 10 seconds the smallest unit of measurement used.

The fact that the standard deviations of the groups in Tables 2 to 11, tested in various stages of infections, were all large is, beyond the 10 second S. D. of the normal group, of no significance as regards method. Therefore, these deviations are due not to breaks in technic but to the biological fact that some birds have a prolonged bleeding time in malaria and others do not. This is shown better in Table 19 where the tests are grouped to indicate what percentage of birds in each group have bleeding times of 100 seconds or more; that is, two or more times the normal. It is seen that in one hundred eighty normal tests none was found to be 100 seconds or more; but after in-

fection, from the fifth to the eighth day, these prolonged bleeding times begin to appear. On the eighth day 52.4 per cent of the birds had a bleeding time of 100 seconds or more. The average of this 52.4 per cent of birds is 164.5 seconds, more than three times normal. Only one bird in twenty one had a normal bleeding time and in two others there was only a slight increase.

One can not look to blood platelets or an explanation of the increased bleeding time since, as already noted, these elements are not found in avian blood. There is perhaps some evidence in Tables 15 and 16 that the increase in bleeding time is related to a decrease in red blood cells, and in Tables 17 and 18 the evidence possibly links bleeding time and blood calcium. But at the best these results are inconclusive and further studies are indicated, which will include an investigation of coagulation time and thrombocyte density.

It is of course interesting, but at present idle, to speculate as to possible relationships between bleeding time, calcium content, malaria, and black-water fever. If the calcium content is lowered in acute malaria, what is the reason and what becomes of the calcium? These and other questions remain to be answered.

TABLE 19.—*Percentage of birds having bleeding times 100 seconds or longer grouped according to status of malaria infection.*

Status of infection. Days after inoculation.	Number of tests.	Bleeding times 100 seconds or longer.	
		Number.	Per cent.
Normal bird (no infection)	180	0	0
5	11	1	9.1
6	28	9	32.1
7	18	8	44.4
8	21	11	52.4
9	18	7	38.9
10	28	7	25.0
11	17	3	17.6
12	10	1	10.0
13–20	35	4	11.4
21 or more	113	2	1.8

SUMMARY

A brief discussion is presented regarding bleeding time.

Experiments are reported which show that the normal bleeding time in birds is 42.4 ± 10 seconds. The bleeding time in

acute avian malaria has been found to be frequently longer than in normal birds. This prolonged bleeding time coincides with, but is not necessarily caused by, a decrease in the number of red blood cells and apparently a decrease in the calcium content of the blood.

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ILLUSTRATIONS

PLATE 1. Normal bleeding time in avian malaria; set 1.
2. Normal bleeding time in avian malaria; set 2.
3. Bleeding time in acute avian malaria; set 1.
4. Bleeding time in acute avian malaria; set 2.
5. Bleeding time in chronic avian malaria.

TEXT FIGURE

FIG. 1. Graph showing bleeding time in seconds in groups of birds, normal and at varying periods after inoculations. (See Tables 1 to 11.)

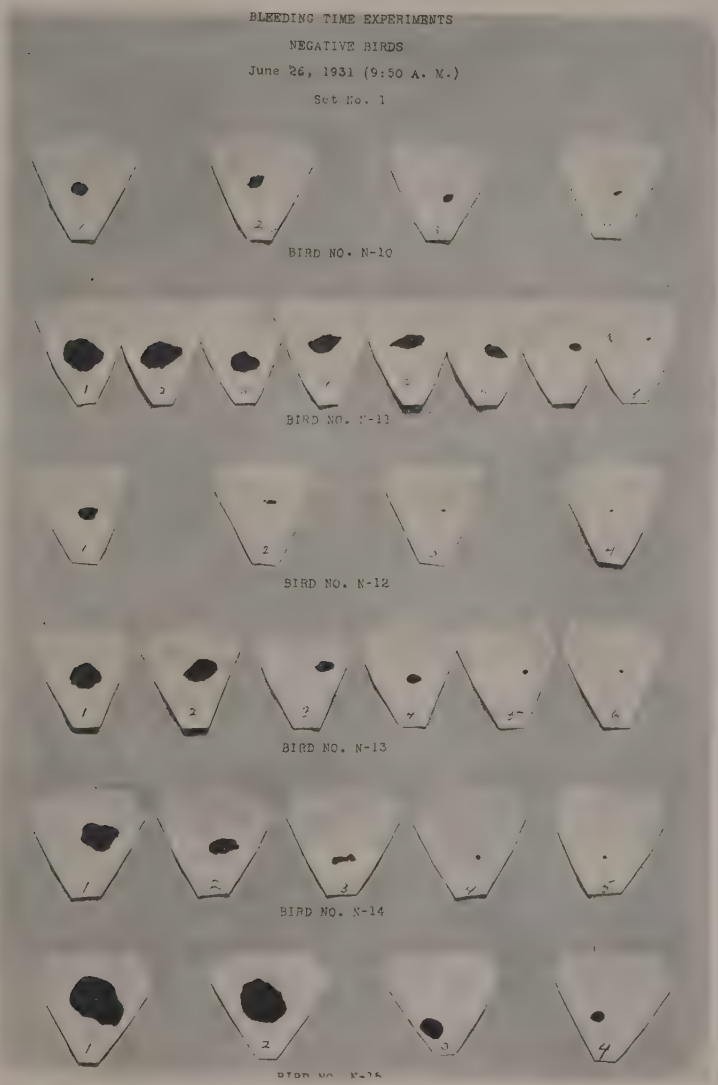

PLATE 1. NORMAL BLEEDING TIME IN AVIAN MALARIA; SET 1.

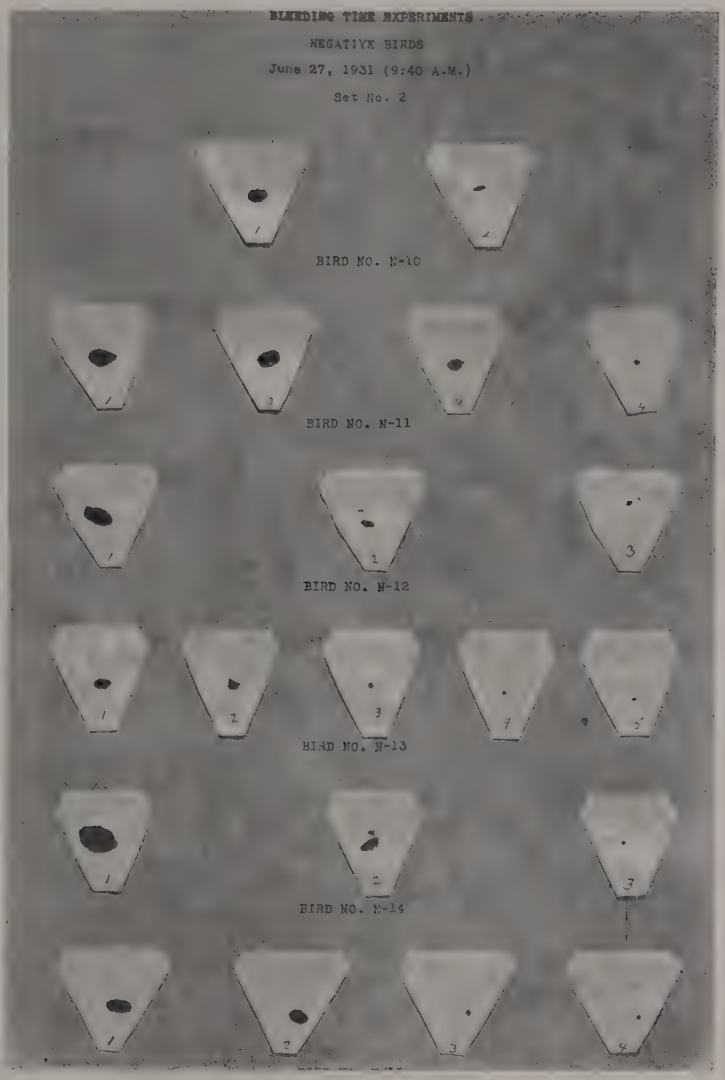

PLATE 2. NORMAL BLEEDING TIME IN AVIAN MALARIA; SET 2.

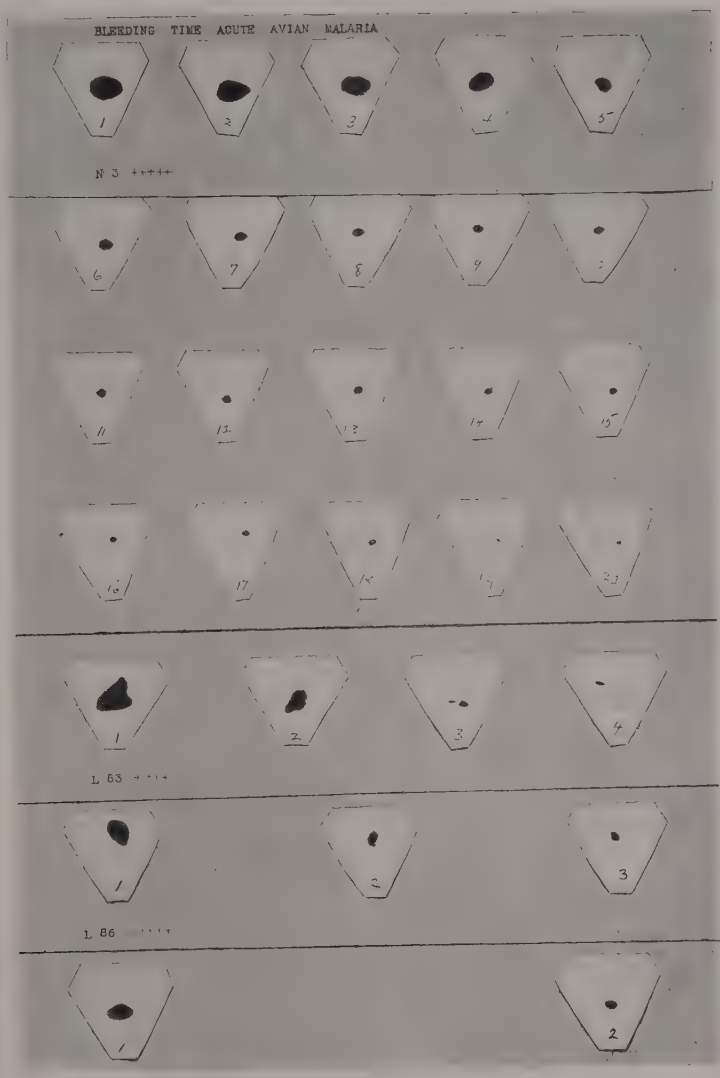

PLATE 3. BLEEDING TIME IN ACUTE AVIAN MALARIA; SET 1.

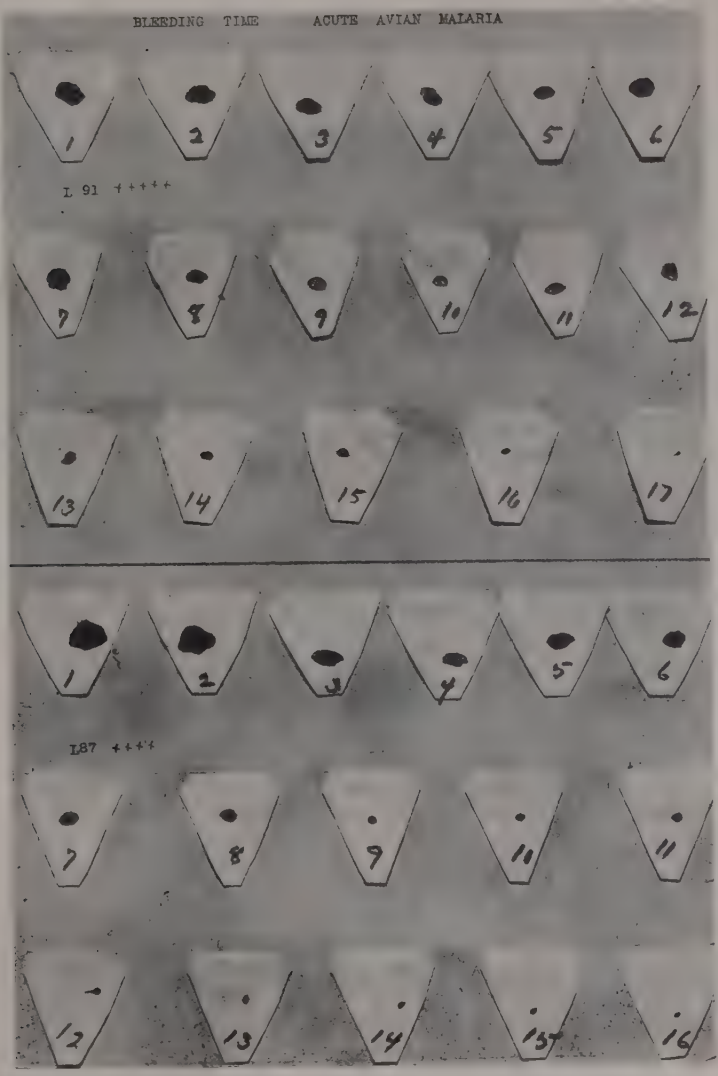

PLATE 4. BLEEDING TIME IN ACUTE AVIAN MALARIA; SET 2.

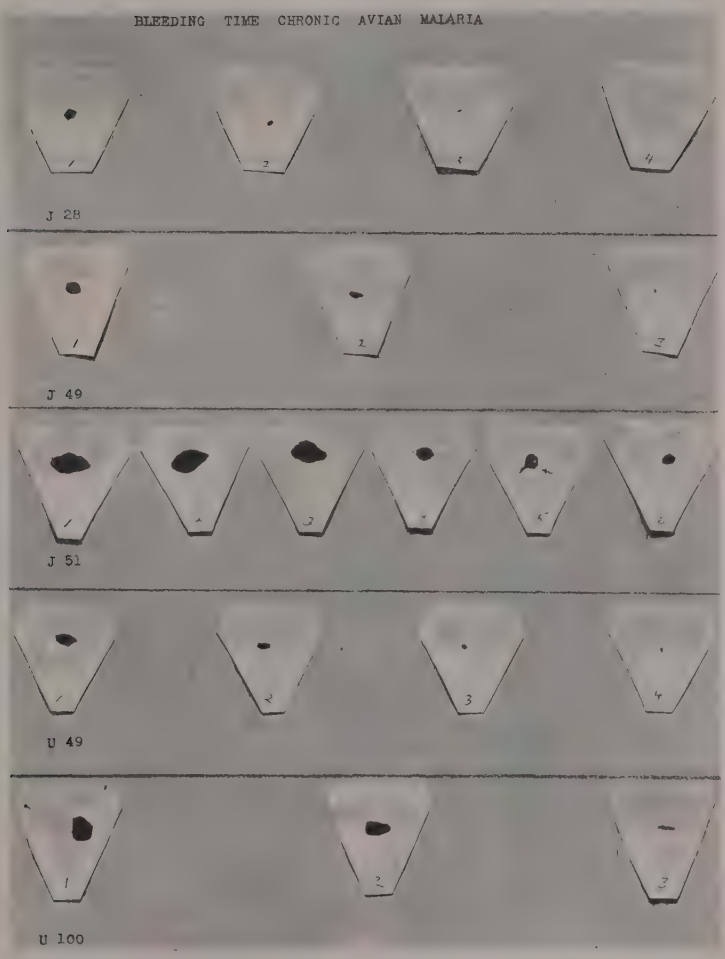

PLATE 5. BLEEDING TIME IN CHRONIC AVIAN MALARIA.

THE EFFECT ON CULEX LARVÆ OF PARIS GREEN DILUTED WITH CHARCOAL AND NOTES ON THE FEEDING HABITS OF CULEX QUINQUEFASCIATUS LARVICIDE STUDIES, V [1]

By Paul F. Russell

Of the International Health Division of the Rockefeller Foundation

and

Augustus P. West

Of the Bureau of Science, Manila

THREE PLATES AND ONE TEXT FIGURE

In previous articles [2] charcoal was suggested as a diluent and partial adsorbent for Paris green mixtures prepared in the usual way for the destruction of anopheles larvæ. In this paper experiments are reported which indicate that under certain conditions the usefulness of Paris green-charcoal mixtures is not limited to the destruction of anopheles larvæ. We find that this mixture has a markedly lethal effect on culex larvæ, as well.

It has been commonly stated that one of the chief disadvantages of Paris green as a larvicide is the fact that, as ordinarily applied, it leaves the culicine larvæ unaffected.[3] This failure to kill culicine larvæ has been a serious drawback to the use of Paris green not only because certain of the culicines are disease carriers but also because laymen never differentiate in a practical way the two genera *Anopheles* and *Culex*.

[1] These studies were undertaken by the Bureau of Science, divisions of organic chemistry and of malaria investigations. The latter is coöperatively supported by the Bureau and by the International Health Division of the Rockefeller Foundation. Mrs. I. Ramos and Miss Victoria Masilungan, microscopists of malaria investigations, assisted in these experiments.

[2] Russell, P. F., and A. P. West, Philip. Journ. Sci. 49 (1932) 211.

[3] Barber, M. A., and T. G. Hayne, U. S. Pub. Health Rep. 36 (1921) 8; Hardenburg, W. E., Mosquito Eradication (1922) 163; Covell, Gordon, Malaria Control by Anti-Mosquito Measures (1931) 70.

A campaign to control malaria by attacking only the anopheles larvæ may become discredited by the public concerned before its effect is realized because culex mosquitoes continue to be prevalent and annoying.

In explanation of the failure of Paris green to kill culex larvæ it is usually stated that Culex larvæ are not surface feeders as are the anophelines and consequently are not able to ingest the floating particles of the larvicide. Griffitts [4] experimented with a mixture of 1 part Paris green and 100 parts of moist sand. This diluent carried a high proportion of the Paris green to the bottom of the pond where it was used. Some Paris green was left on the surface of the water, either floating free or adherent to floating particles of sand. He found in a series of experiments that Paris green applied in this manner is lethal to culex and aëdes mosquitoes. He concluded, "now that it has been determined that these sub-surface-feeding larvæ are highly susceptible to the toxic action of Paris green, it remains to determine the best methods of applying this mixture to the areas requiring treatment."

It should also be noted that Williams and Cook [5] in a series of experiments, in which Paris green diluted with powdered soapstone was spread by airplane, killed a high percentage of culex larvæ in their first three experiments. Subsequently, Paris green had little or no effect on culex larvæ.

EXPERIMENTAL PROCEDURE

The mixture used in these experiments was made with 1 part Paris green and 99 parts of powdered wood charcoal. The charcoal floated easily upon the surface of water. Certain kinds of charcoal do not float so well and are not suitable for experiments such as these. In the laboratory only third- and fourth-stage larvæ of the species *Culex quinquefasciatus* (*fatigans*) were used and the amount of larvicide spread on the pans was carefully determined. Larvæ were not pronounced dead until all motion had ceased. Control pans, beakers, or jars were always used with the same species of larvæ, the same water, and external influences.

In the pond experiments the dipping was standardized by marking out regular stations around the pond, by making one

[4] U. S. Pub. Health Rep. 42 (1927) 2701.
[5] U. S. Pub. Health Rep. 42 (1927) 459.

dip each time in a prescribed way, and by turning back the living catch each time. The larvicidal mixture was applied with a hand bellows (blower) which was weighed with its contents before and after use. The sides and the bottom of the pond (Plate 1) were made of concrete. The measurements of the pond, which bulged out beyond the curve of a circle, were as follows: Length, 4.9 meters; width, 4.83 meters; depth, 0.593 meter; calculated surface area, 20.1 square meters.

RESULTS

In Table 1 are presented the results of some tests of the larvicidal properties of this charcoal-Paris green mixture using culex larvæ. Laboratory containers of different heights (Plate 2) were used as noted in the table.

It will be seen that there was a well-marked lethal effect on the culex larvæ in each of the experiments, but the quick and complete results seen in the experiments with anopheles larvæ in our first paper [6] were not obtained. It takes more time to kill culex larvæ with Paris-green because, as noted below, their feeding habits are different.

In Table 2 are the results of similar experiments with Paris green but using other vehicles than charcoal. Here the results are not quite so good. Sand mixture does nearly as well as charcoal but lime and rice-stalk ashes as diluents distinctly lower the effectiveness of Paris green.

In Tables 3, 4, and 5 are reported the results of three experiments carried out in the open in a fishpond at the Bureau of Science. This pond was made available by the courtesy of Mr. Wallace Adams, chief of the division of fisheries, Bureau of Science.

Inspection of the tables will show that, in a pond of still water, Paris-green and charcoal mixture blown on the surface is an effective larvicide against culex mosquitoes. It is slower to act, however, than against anopheles larvæ and not quite so effective.

In the first experiment the larvæ were not completely eradicated but the total catch dropped from 1023 on the 17th to 12 on the 20th. This experiment was discontinued because one pregnant mosquito fish had inadvertently been left in the pond, or had gotten in, and had given birth to a litter of young fish on the morning of the 17th. After this experience not only was

[6] Philip. Journ. Sci. (in press).

the water removed from the pond but also all of the mud at the bottom. The pond was then filled with fresh water for subsequent experiments.

Many dead larvæ were found on the mornings of the 18th, 19th, and 20th. On dissection charcoal and Paris green particles were found in the gut of these larvæ.

In the second and third experiments, as shown in Tables 4, and 5, complete disappearance of the larvæ at the dipping stations was observed. Larvæ were very slow to reappear in the pond after each application of Paris green.

In Table 6 is a record of larvæ which pupated a few hours after the application of the Paris green in the second pond experiment (Table 4). It will be noted that most of these larvæ subsequently emerged as adults. In other words the charcoal-Paris green mixture did not act quickly enough to harm them.

DISCUSSION

It is clear that arsenic is not only lethal to anopheles larvæ but also to culex. This has been demonstrated by Griffitts [7] and by the experiments reported in this paper. The question is how the larvæ ingest the Paris green.

In order to kill culex larvæ with Paris green, it must be made available to them. Griffitts accomplished this by sinking the Paris green with moist sand. We have had good results, as shown above, by mixing charcoal with Paris green. The charcoal floats indefinitely and the Paris green is supported by the charcoal. The culex larvæ have sufficient time to ingest a lethal dose. With anopheles larvæ the period required to ingest a lethal dose of Paris green floating on the surface is measured in minutes, with culex larvæ it is measured in hours. Therefore, a charcoal and Paris green mixture applied on running water in ditches would probably have considerably less effect on culex larvæ than it has had in a still-water pond in our experiments. For water standing in fire buckets, still ponds, and similar places it would seem that Paris green-charcoal mixtures would be very useful as a culex larvicide.

Another point to notice, as brought out in Tables 3, 4, and 5, is that the persistent floating properties of the charcoal result in a film which lasts for days instead of hours. This film appears to act as a deterrent. It also keeps the Paris green

[7] U. S. Pub. Health Rep. 42 (1927) 2701.

available for the larvæ which hatch subsequently or which at the time of application are too small to ingest the larvicide.

It is not the purpose of this paper to recommend Paris green as the larvicide of choice for culex mosquitoes; but to point out that in an antimalaria attack on anopheles mosquito larvæ, in localities where the carrier breeds in still water, Paris green used with charcoal will kill not only all of the anopheles larvæ but also most and sometimes all of the culex larvæ as well.

FEEDING HABITS OF CULEX QUINQUEFASCIATUS LARVÆ

In Tables 7 and 8 are the results of some observations made to determine something of the feeding habits of culex larvæ. An investigation of these habits reveals that culex larvæ are more versatile than anopheles larvæ. Culex larvæ feed at the surface, below the surface, and at the bottom. In a group of culex larvæ, at a given time, under the same conditions, and in the same laboratory pan or outdoor breeding place, some will be found feeding at the surface, some at the bottom, and a larger number just beneath the surface hanging head down as in the classical illustrations.

In Table 7, are given the results of fifty-two observations on the feeding habits of the larvæ of *Culex quinquefasciatus*. As shown by the data an average of 12 per cent of the larvæ were feeding at the bottom of the pan, 15 per cent at the surface, and 73 per cent in the subsurface position.

If the larvæ are placed in a jar in which the depth of the water is relatively great (56.7 centimeters) very few, if any, larvæ will be found at the bottom. The results of sixty observations (Table 8) show that an average of about 21 per cent of the larvæ were feeding at the surface. An average of about 69 per cent were feeding in the usual subsurface position, and only two larvæ were seen at the bottom. An average of about 11 per cent were in a deep subsurface position. These larvæ were not feeding but exploring about 15 centimeters below the water surface.

It is necessary to be careful in referring to culex larvæ to make it plain that they do not feed constantly in one position relative to the surface of the water. Depth of water and conditions of food supply have, of course, a definite influence.

Text fig. 1, drawn from life, illustrates the position of culex larvæ when feeding at the surface. By a relatively powerful action of abdominal muscles the head is raised to the surface,

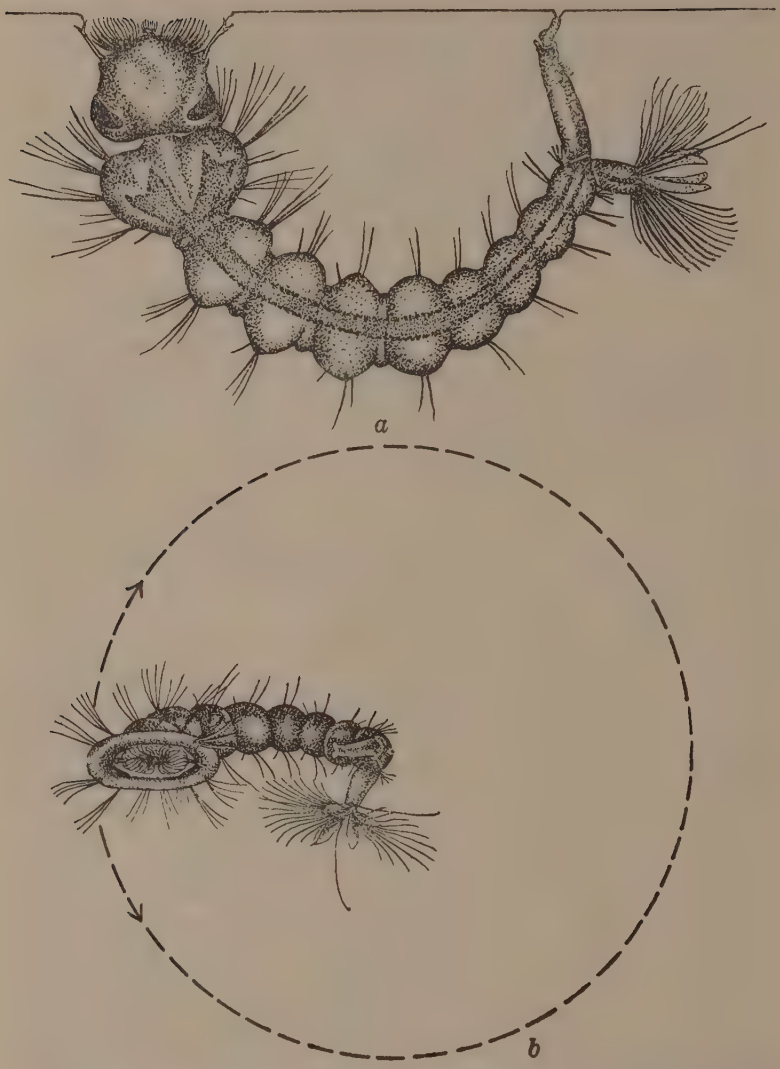

FIG. 1. *Culex quinquefasciatus; a,* position when feeding at the surface; *b,* pivoting maneuver when feeding at the surface. (Drawn from life, by L. Moskaira.)

the body of the larva being bent like a bow. With the siphon as a fixed pivot the larva swings around and around, now clockwise and now counter clockwise, using the mouth parts and brushes to accomplish this unique feeding maneuver. This has been observed time and again in these experiments.

Plate 3 shows photographs of intestinal tracts dissected from *Culex quinquefasciatus* larvæ after feeding on charcoal and Paris green mixture floating on the surface of water in a pan. The charcoal observed in the intestinal tract shows that the culex larvæ actually ingest material which floats on the surface of water and that this material passes into and fills the intestinal tract.

In view of these observations it is not strange that Paris green, if kept afloat long enough, will kill culex larvæ. So too, when carried to the bottom, Paris green is also available to culex larvæ if the water is shallow, but the feeding time at the surface is greater than at the bottom. Moreover, at the surface both culex and anopheles larvæ take the Paris green mixture.

SUMMARY

Charcoal mixed with Paris green, 99 parts to 1, has been shown to be an effective larvicide against culex mosquitoes in laboratory containers and in a pond where the water was not moving.

An investigation of the feeding habits of *Culex quinquefasciatus* shows that these larvæ feed at the surface, below the surface, and at the bottom of shallow water.

Paris green, if supported by charcoal and kept afloat, will not only destroy all anopheles larvæ but will kill a high percentage of *Culex quinquefasciatus* larvæ as well.

TABLE 1.—*Larvicidal effect of Paris green-charcoal mixture (1 to 100) on Culex quinquefasciatus larvæ. Experiments made in laboratory containers.*

[In each experiment there were used 50 larvæ of third and fourth stage.]

Test No.	Type of container.	Depth of water.	Area of water surface.	Weight of larvicide.	Percentage of dead larvæ. Cumulative totals in time periods (hours).									Pupæ.
					1	2	3	4	5	6	24	48	72	
		cm.	*sq. cm.*	*g.*										
1	Pan	3.0	600.0	0.1	0	0	2	8	18	24	86	98	100	0
2	do	3.0	600.0	0.1	0	2	4	4	20	34	84	96	100	1
3	do	3.0	600.0	[a]	0	0	0	0	0	0	2	6	10	4
4	do	3.0	600.0	[a]	0	2	2	6	6	6	10	10	10	1
5	Beaker	21.6	254.5	0.1	0	0	2	10	14	38	78	86	88	4
6	do	21.6	254.5	0.1	2	2	16	56	60	72	96	100	100	0
7	do	21.6	254.5	[a]	0	0	0	0	0	0	0	2	6	2
8	Jar	59.0	314.2	0.1	2	4	4	6	12	12	96	96	96	0
9	do	59.0	314.2	0.1	0	0	0	0	------	------	92	98	98	0
10	do	59.0	314.2	0.1	0	0	2	2	2	------	10	74	88	0
11	do	59.0	314.2	0.1	0	0	0	0	------	------	80	90	98	0
12	do	59.0	314.2	[a]	0	0	0	0	0	0	0	0	0	8
13	do	59.0	314.2	[a]	0	0	0	0	0	0	0	0	0	17
14	do	59.0	314.2	[a]	0	0	0	0	------	------	4	4	4	30

[a] Control test.

TABLE 2.—*Larvicidal effect on Culex quinquefasciatus larvæ of Paris green mixtures (1 to 100) with diluents other than charcoal.*[a]

Test No.	Diluent used.	Percentage of dead larvæ. Cumulative totals in time periods (hours).									Pupæ.
		1	2	3	4	5	6	24	48	72	
1	Sand	0	2	2	2	4	4	40	62	84	0
2	do	0	2	2	2			66	90	94	1
3	Lime	0	0	8	10	14		28	76	76	0
4	do	0	0	2	2			74	86	88	5
5	do	0	0	2	2			10	12	52	8
6	do	0	0	0	4	4	6	20	70	76	0
7	Rice-stalk ashes	0	0	0	2	2		30	36	58	1
8	do	0	0	0	0	2	6	8	60	72	0
9	do	0	0	0	0	2	8	10	50	64	2
10	Control	0	0	0	0	0	0	0	0	0	13
11	do	0	0	2	2	2	2	2	2	2	9
12	do	0	0	0	0	0	0	0	0	0	1
13	do	0	0	0	0	0	0	2	4	4	1

[a] In each test 50 *Culex quinquefasciatus* larvæ were used. The container was a jar with surface area of 314.2 square centimeters and water depth of 59 centimeters. In each case 0.1 gram of the larvicide mixture was used.

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TABLE 3.—*First experiment with Paris green-charcoal mixture (1 to 100) as larvicide for culex larvæ. (Experiment carried out in a pond at the Bureau of Science in 1932.)*[a]

Date and stages of larvæ and pupæ.	Catching stations.																		Total.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
FEBRUARY 11, 9 A. M.																			
Larvæ:																			
Stages 1 and 2	3	0	0	0	0	1	6	1	2	3	6	1	4	0	0	0	0	0	27
Stages 3 and 4	27	2	0	0	1	1	74	6	6	3	4	10	7	2	0	1	2	3	149
Pupæ	0	0	0	0	0	0	4	0	0	1	2	0	0	0	0	0	0	0	7
Larvæ and pupæ totals:																			
Living	30	2	0	0	1	2	84	7	8	7	12	11	11	2	0	1	2	3	183
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEBRUARY 12, 9 A. M.																			
Larvæ:																			
Stages 1 and 2	1	0	1	0	0	0	21	8	12	13	37	21	10	20	0	0	0	0	144
Stages 3 and 4	18	23	16	5	8	7	41	40	22	53	199	27	33	36	1	1	0	2	532
Pupæ	2	1	0	0	0	1	15	8	5	10	66	6	8	1	0	0	1	0	124
Larvæ and pupæ totals:																			
Living	21	24	17	5	8	8	77	56	39	76	302	54	51	57	1	1	1	2	800
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEBRUARY 13, 9 A. M.																			
Larvæ:																			
Stages 1 and 2	258	12	22	36	25	16	65	39	41	46	444	82	35	132	2	8	0	1	1,264
Stages 3 and 4	72	16	8	76	32	13	25	17	15	26	52	17	41	34	2	1	3	0	450
Pupæ	3	0	0	8	12	5	9	0	1	0	20	0	0	5	1	2	0	0	66
Larvæ and pupæ totals:																			
Living	333	28	30	120	69	34	99	56	57	72	516	99	76	171	5	11	3	1	1,780
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

FEBRUARY 14, 9 A. M.																			
Larvæ:																			
Stages 1 and 2	226	59	49	51	28	34	45	25	24	17	200	67	25	25	7	3	1	6	892
Stages 3 and 4	40	18	13	9	10	21	8	28	20	36	42	18	14	6	5	10	4	3	305
Pupæ	10	2	5	9	0	9	21	3	1	6	0	7	5	2	1	3	0	0	84
Larvæ and pupæ totals:																			
Living	276	79	67	69	38	64	74	56	45	59	242	92	44	33	13	16	5	9	1,281
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEBRUARY 15, 9 A. M.																			
Larvæ:																			
Stages 1 and 2	162	37	41	42	70	112	105	4	18	20	99	20	0	4	2	7	6	3	752
Stages 3 and 4	75	28	17	10	82	145	29	16	22	24	109	9	15	5	2	7	8	4	607
Pupæ	6	15	5	0	4	3	5	3	10	16	7	1	0	0	0	5	7	2	89
Larvæ and pupæ totals:																			
Living	243	80	63	52	156	260	139	23	50	60	215	30	15	9	4	19	21	9	1,448
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEBRUARY 16, 9 A. M.																			
Larvæ:																			
Stages 1 and 2	20	14	24	19	16	12	134	10	9	23	97	12	30	11	3	11	4	1	450
Stages 3 and 4	34	10	14	19	29	19	24	6	13	13	132	13	12	12	13	15	4	4	386
Pupæ	6	3	7	14	7	3	1	1	0	4	13	4	3	2	15	5	3	6	97
Larvæ and pupæ totals:																			
Living	60	27	45	52	52	34	159	17	22	40	242	29	45	25	31	31	11	11	933
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEBRUARY 17, 9 A. M.																			
Larvæ:																			
Stages 1 and 2	21	11	8	29	16	24	17	74	8	26	13	14	12	17	9	4	49	12	364
Stages 3 and 4	23	28	11	20	6	17	12	70	20	23	41	10	11	16	13	7	34	13	557
Pupæ	3	5	2	30	14	5	2	2	4	4	2	8	6	0	2	0	8	5	102
Larvæ and pupæ totals:																			
Living	47	44	21	261	36	46	31	146	32	53	56	32	29	33	24	11	91	30	1,023
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

[a] February 10, 1932, 1 p. m., there were placed in the pond 1,515 larvæ of third and fourth stage. February 11, 1932, 2.30 p. m., 9,500 third- and fourth-stage larvæ were also added. February 17, 1932, 10 a. m., 207.9 grams of Paris green-charcoal mixture (1 to 100) were blown over the pond with a hand bellows. February 29, 1932, 9 a. m., the charcoal was still floating evenly on the surface of the water. Some mosquito fish were noticed in the pool.

TABLE 3.—*First experiment with Paris green-charcoal mixture (1 to 100) as larvicide for culex larvæ. (Experiment carried out in a pond at the Bureau of Science in 1932.)*[a]—Continued.

Date and stages of larvæ and pupæ.	Catching stations.																		Total.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
FEBRUARY 18, 9 A. M.																			
Larvæ:																			
Stages 1 and 2	0	1	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	1	6
Stages 3 and 4	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	2
Pupæ	4	2	0	0	3	1	1	1	0	0	0	0	1	0	1	5	0	2	21
Larvæ and pupæ totals:																			
Living	4	3	1	1	3	1	2	2	0	0	1	0	2	0	1	5	0	3	29
Dead	5	2	4	6	7	8	4	4	8	7	6	5	5	6	7	8	7	6	105
FEBRUARY 19, 9 A. M.																			
Larvæ:																			
Stages 1 and 2	1	0	0	1	1	2	2	0	2	2	1	0	0	0	0	0	0	0	12
Stages 3 and 4	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	1	0	0	5
Pupæ	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	2
Larvæ and pupæ totals:																			
Living	1	0	1	2	1	3	2	0	2	2	1	1	0	1	1	1	0	0	19
Dead	0	1	1	4	0	1	0	4	2	4	0	5	1	4	0	1	1	3	32
FEBRUARY 20, 9 A. M.																			
Larvæ:																			
Stages 1 and 2	0	0	0	0	0	0	0	2	0	0	1	1	0	0	1	1	0	0	6
Stages 3 and 4	0	0	0	0	0	0	2	0	0	0	2	0	0	1	0	0	0	1	6
Pupæ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Larvæ and pupæ totals:																			
Living	0	0	0	0	0	0	2	2	0	0	3	1	0	1	1	1	0	1	12
Dead	0	0	1	0	1	1	0	0	0	0	1	0	0	1	0	0	0	1	7

[a] February 10, 1932, 1 p. m., there were placed in the pond 1,515 larvæ of third and fourth stage. February 11, 1932, 2.30 p. m., 9,500 third- and fourth-stage larvæ were also added. February 17, 1932, 10 a. m., 207.9 grams of Paris green-charcoal mixture (1 to 100) were blown over the pond with a hand bellows. February 29, 1932, 9 a. m., the charcoal was still floating evenly on the surface of the water. Some mosquito fish were noticed in the pool.

TABLE 4.—*Second experiment with Paris green-charcoal mixture (1 to 100) as larvicide for culex larvæ. (Experiment carried out in a pond at the Bureau of Science.)*[a]

Date and stages of larvæ and pupæ.	Catching stations.																		Total.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
MARCH 3, 9 A. M.																			
Larvæ:																			
Stages 1 and 2	6	2	1	1	0	0	0	0	1	0	4	0	0	2	0	1	0	0	18
Stages 3 and 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pupæ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Larvæ and pupæ totals:																			
Living	6	2	1	1	0	0	0	0	1	0	4	0	0	2	0	1	0	0	18
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MARCH 4, 9 A. M.																			
Larvæ:																			
Stages 1 and 2	3	3	2	1	2	1	20	4	0	3	2	1	2	4	1	1	0	0	50
Stages 3 and 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pupæ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Larvæ and pupæ totals:																			
Living	3	3	2	1	2	1	20	4	0	3	2	1	2	4	1	1	0	0	50
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

[a] The experiment was started February 28, 1932, 9 a. m. On that date and February 29, March 1, and March 2 there were no larvæ or pupæ in the pool as determined by tests made those dates at all the catching stations around the pool. March 5, 9.30 a. m., 3,000 third and fourth-stage larvæ were placed in the pool. March 8, 4.15 p. m., 3,440 third and fourth-stage larvæ were also placed in the pool. March 9, 9.30 a. m., 90.4 grams of Paris green-charcoal mixture (1 to 100) were sprayed over the pool with a hand blower.

The day was hot with the sun shining brightly and the wind calm. The Paris green mixture spread nicely over the surface of the water. March 12 the Paris green mixture was only very thinly spread on the surface of the pond. The following days the mixture gradually disappeared until March 17 only a very small amount of Paris green remained.

TABLE 4.—*Second experiment with Paris green-charcoal mixture (1 to 100) as larvicide for culex larvæ. (Experiment carried out in a pond at the Bureau of Science.)*[a]—Continued.

Date and stages of larvæ and pupæ.	Catching stations.																	Total.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
MARCH 5, 9 A. M.																			
Larvæ:																			
Stages 1 and 2	13	3	5	6	1	4	79	2	1	4	5	0	2	1	0	0	0	1	127
Stages 3 and 4	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	1	0	4
Pupæ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Larvæ and pupæ totals:																			
Living	13	3	5	6	2	4	79	2	1	5	5	0	2	1	1	0	1	1	131
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MARCH 6, 9 A. M.																			
Larvæ:																			
Stages 1 and 2	15	6	3	4	4	4	74	4	2	1	6	2	2	4	1	1	0	0	133
Stages 3 and 4	6	0	4	0	2	0	26	2	4	6	23	2	0	0	0	2	1	1	79
Pupæ	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	2
Larvæ and pupæ totals:																			
Living	21	6	7	4	6	4	101	6	6	7	29	5	2	4	1	3	1	1	214
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MARCH 7, 9 A. M.																			
Larvæ:																			
Stages 1 and 2	88	18	17	30	136	3	53	15	2	2	5	10	7	3	0	0	2	4	395
Stages 3 and 4	18	14	8	5	32	4	27	3	4	2	5	2	2	5	1	1	3	2	138
Pupæ	0	0	0	0	2	0	2	0	1	0	1	0	0	0	1	0	0	0	7
Larvæ and pupæ totals:																			
Living	106	32	25	35	170	7	82	18	7	4	11	12	9	8	2	1	5	6	540
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MARCH 8, 9 A. M.																			
Larvæ:																			
Stages 1 and 2	19	16	3	25	53	35	121	23	57	7	14	3	15	43	0	5	0	1	440
Stages 3 and 4	2	2	2	9	8	13	6	1	4	3	1	27	2	1	0	0	1	0	82

Pupæ	2	0	1	1	1	3	2	3	1	1	1	0	2	0	1	1	1	1	22
Larvæ and pupæ totals:																			
Living	23	18	6	35	62	51	129	27	62	11	16	30	19	44	1	6	2	2	544
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MARCH 9, 9 A. M.																			
Larvæ:																			
Stages 1 and 2	14	11	34	11	18	23	17	9	13	13	17	2	4	18	6	2	0	4	216
Stages 3 and 4	37	12	19	15	42	63	61	14	6	32	137	26	8	9	3	4	5	6	499
Pupæ	5	0	2	2	3	7	30	0	3	4	58	3	4	3	0	0	2	0	126
Larvæ and pupæ totals:																			
Living	56	23	55	28	63	93	108	23	22	49	212	31	16	30	9	6	7	10	841
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MARCH 9, 3.30 P. M.																			
Larvæ:																			
Stages 1 and 2	1	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4
Stages 3 and 4	2	0	3	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	8
Pupæ	8	0	0	0	0	2	35	2	0	0	3	0	0	2	0	1	1	1	55
Larvæ and pupæ totals:																			
Living	11	0	3	2	0	2	36	2	1	1	3	0	0	2	0	1	1	2	67
Dead	4	2	4	2	2	2	0	2	0	2	2	1	1	4	4	0	0	2	34
MARCH 10, 9.30 A. M.																			
Larvæ:																			
Stages 1 and 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Stages 3 and 4	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Pupæ	6	0	1	0	1	0	6	0	1	1	7	5	1	4	0	0	1	0	34
Larvæ and pupæ totals:																			
Living	6	0	1	0	1	0	6	0	2	1	7	5	1	4	1	0	1	0	36
Dead	2	1	2	1	2	0	2	2	0	1	0	1	1	0	1	0	0	2	18

[a] The experiment was started February 28, 1932, 9 a. m. On that date and February 29, March 1, and March 2 there were no larvæ or pupæ in the pool as determined by tests made those dates at all the catching stations around the pool. March 5, 9.30 a. m., 3,000 third and fourth-stage larvæ were placed in the pool. March 8, 4.15 p. m., 3,440 third and fourth-stage larvæ were also placed in the pool. March 9, 9.30 a. m., 90.4 grams of Paris green-charcoal mixture (1 to 100) were sprayed over the pool with a hand blower.

The day was hot with the sun shining brightly and the wind calm. The Paris green mixture spread nicely over the surface of the water. March 12 the Paris green mixture was only very thinly spread on the surface of the pond. The following days the mixture gradually disappeared until March 17 only a very small amount of Paris green remained.

TABLE 4.—*Second experiment with Paris green-charcoal mixture (1 to 100) as larvicide for culex larvæ. (Experiment carried out in a pond at the Bureau of Science.)*[a]—Continued.

Date and stages of larvæ and pupæ.	Catching stations.																	Total.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
MARCH 11, 9.30 A. M.																			
Larvæ:																			
Stages 1 and 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stages 3 and 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pupæ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Larvæ and pupæ totals:																			
Living	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dead	1	2	1	0	1	0	2	0	0	0	1	0	1	0	1	0	0	0	10
MARCH 12, 9.30 A. M.																			
Larvæ:																			
Stages 1 and 2	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	3
Stages 3 and 4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Pupæ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Larvæ and pupæ totals:																			
Living	0	0	0	0	1	0	2	0	0	0	1	0	0	0	0	0	0	0	4
Dead	1	0	1	0	0	0	0	1	0	1	1	1	1	0	1	0	1	0	9
MARCH 13, 9.30 A. M.																			
Larvæ:																			
Stages 1 and 2	1	2	1	0	0	3	9	1	0	1	1	3	1	0	0	0	0	0	23
Stages 3 and 4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pupæ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Larvæ and pupæ totals:																			
Living	2	2	1	0	0	3	9	1	0	1	1	3	1	0	0	0	0	0	24
Dead	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
MARCH 14, 9.30 A. M.																			
Larvæ:																			
Stages 1 and 2	4	1	1	1	1	1	5	1	2	1	3	0	1	2	0	1	0	0	25
Stages 3 and 4	0	0	0	0	0	1	1	0	0	1	0	1	0	1	0	0	0	0	5

Pupæ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Larvæ and pupæ totals:																				
Living	4	1	1	1	1	2	6	1	2	2	3	1	1	3	0	1	0	0	0	30
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MARCH 15, 9.30 A. M.																				
Larvæ:																				
Stages 1 and 2	0	2	0	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	6
Stages 3 and 4	2	1	1	1	1	3	9	1	0	0	2	1	0	1	1	0	0	0	0	24
Pupæ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Larvæ and pupæ totals:																				
Living	2	3	1	4	1	3	9	1	1	0	2	1	0	1	1	0	0	0	0	30
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MARCH 16, 9.30 A. M.																				
Larvæ:																				
Stages 1 and 2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Stages 3 and 4	5	1	2	1	1	1	1	2	1	1	4	1	1	1	1	0	0	0	0	24
Pupæ	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Larvæ and pupæ totals:																				
Living	6	1	2	1	1	1	1	2	1	1	5	1	1	1	1	0	0	0	0	26
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MARCH 17, 9.30 A. M.																				
Larvæ:																				
Stages 1 and 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stages 3 and 4	1	2	0	2	1	4	4	0	1	1	1	1	0	1	0	0	1	0	0	20
Pupæ	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Larvæ and pupæ totals:																				
Living	1	2	0	2	1	4	5	0	1	1	1	1	0	1	0	0	1	0	0	21
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

[a] The experiment was started February 28, 1932, 9 a. m. On that date and February 29, March 1, and March 2 there were no larvæ or pupæ in the pool as determined by tests made those dates at all the catching stations around the pool. March 5, 9.30 a. m., 3,000 third and fourth-stage larvæ were placed in the pool. March 8, 4.15 p. m., 3,440 third and fourth-stage larvæ were also placed in the pool. March 9, 9.30 a. m., 90.4 grams of Paris green-charcoal mixture (1 to 100) were sprayed over the pool with a hand blower.

The day was hot with the sun shining brightly and the wind calm. The Paris green mixture spread nicely over the surface of the water. March 12 the Paris green mixture was only very thinly spread on the surface of the pond. The following days the mixture gradually disappeared until March 17 only a very small amount of Paris green remained.

TABLE 5.—*Third experiment with Paris green-charcoal mixture (1 to 100) as larvicide for culex larvæ. (Experiment carried out in a pond at the Bureau of Science.)*[a]

Date and stages of larvæ and pupæ.	Catching stations.																	Total.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
MARCH 18, 9.30 A. M.																			
Larvæ:																			
Stages 1 and 2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Stages 3 and 4	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
Pupæ	0	0	0	1	1	1	2	1	1	0	1	0	0	0	1	0	1	0	10
Larvæ and pupæ totals:																			
Living	0	0	1	2	1	1	2	1	2	0	1	0	0	0	1	0	1	0	13
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
MARCH 22, 8 A. M.																			
Larvæ:																			
Stages 1 and 2	22	0	5	2	4	6	0	3	4	7	36	10	8	4	2	1	1	1	116
Stages 3 and 4	34	2	1	1	0	1	5	4	7	18	89	12	9	4	2	1	0	1	191
Pupæ	6	0	0	0	2	0	2	0	1	0	2	1	0	0	0	0	0	0	14
Larvæ and pupæ totals:																			
Living	62	2	6	3	6	7	7	7	12	25	127	23	17	8	4	2	1	2	321
Dead	1	1	0	1	0	0	0	0	0	3	1	1	1	1	0	1	0	1	12
MARCH 22, 3.50 P. M.																			
Larvæ:																			
Stages 1 and 2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Stages 3 and 4	4	1	3	0	0	0	0	1	1	0	4	2	0	0	1	0	2	1	20
Pupæ	3	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	7
Larvæ and pupæ totals:																			
Living	9	1	3	0	0	0	0	1	1	0	6	2	0	0	1	0	4	1	29
Dead	3	1	0	4	2	1	3	2	1	0	2	4	4	1	2	3	1	1	35

MARCH 23, 8 A. M.																			
Larvæ:																			
Stages 1 and 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stages 3 and 4	1	0	0	0	0	0	1	1	1	0	3	1	3	0	0	0	0	0	11
Pupæ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Larvæ and pupæ totals:																			
Living	1	0	0	0	0	0	1	1	1	0	3	1	3	0	0	0	0	0	11
Dead	2	3	1	2	1	4	1	2	6	1	4	0	4	2	4	5	3	2	47
MARCH 24, 8 A. M.																			
Larvæ:																			
Stages 1 and 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stages 3 and 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pupæ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Larvæ and pupæ totals:																			
Living	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dead	0	1	0	0	0	0	0	1	1	0	0	0	0	0	2	3	0	1	9
MARCH 29, 8 A. M.																			
Larvæ:																			
Stages 1 and 2	0	1	0	0	0	0	0	1	2	1	1	1	0	0	0	0	0	0	7
Stages 3 and 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pupæ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Larvæ and pupæ totals:																			
Living	0	1	0	0	0	0	0	1	2	1	1	1	0	0	0	0	0	0	7
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

[a] March 18, 1932, the Paris green mixture from the last experiment had almost disappeared and the following day there was practically none left. However, there were dust and leaves on the surface of the pond. March 19 and 21, 9.30 a. m., tests were made at all the catching stations. March 19, only one pupa was found (station 14). March 21 only one larva of the third and fourth stage was found (station 16). The surface of the pond was cleared of leaves and approximately 11,000 larvæ were added. March 22, 9.30 a. m., there were sprayed over the pond 80.69 grams of Paris green mixture. March 22, 3 p. m., some dead larvæ were taken from the pond and dissected. Particles of Paris green were found but the color had changed from bluish green to light green. March 23, 8 a. m., and March 24, 8 a. m., there was still plenty of Paris green on the surface of the pond but one living larva was found near the side of the pond. March 26, 8 a. m., the Paris green mixture was only thinly spread on the surface of the pond and no larvæ were found. The following day Paris green had disappeared and still no larvæ were found. March 29, 8 a. m., a few small larvæ were noticed along the sides of the pond. The following day the water was very clear and again a few small larvæ were found. These were *Anopheles subpictus* (var. *indefinitus*) and were taken at stations 8, 12, and 17. March 31, 8 a. m., a few small larvæ of *Anopheles subpictus* (var. *indefinitus*) were found in dips taken at station 10.

TABLE 5.—*Third experiment with Paris green-charcoal mixture (1 to 100) as larvicide for culex larvæ. (Experiment carried out in a pond at the Bureau of Science.)*[a]—Continued.

Date and stages of larvæ and pupæ.	Catching stations.																		Total.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
MARCH 30, 8 A. M.																			
Larvæ:																			
Stages 1 and 2	0	2	0	1	0	0	1	1	0	0	0	2	0	0	0	0	1	0	8
Stages 3 and 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pupæ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Larvæ and pupæ totals:																			
Living	0	2	0	1	0	0	1	1	0	0	0	2	0	0	0	0	1	0	8
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MARCH 31, 8 A. M.																			
Larvæ:																			
Stages 1 and 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stages 3 and 4	0	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	4
Pupæ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Larvæ and pupæ totals:																			
Living	0	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	4
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
APRIL 1, 4 P. M.																			
Larvæ:																			
Stages 1 and 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stages 3 and 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pupæ	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	3
Larvæ and pupæ totals:																			
Living	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	3
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

April 2																			
Larvæ:																			
Stages 1 and 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stages 3 and 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pupæ	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2
Larvæ and pupæ totals:																			
Living	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

[a] March 18, 1932, the Paris green mixture from the last experiment had almost disappeared and the following day there was practically none left. However, there were dust and leaves on the surface of the pond. March 19 and 21, 9.30 a. m., tests were made at all the catching stations. March 19, only one pupa was found (station 14). March 21 only one larva of the third and fourth stage was found (station 16). The surface of the pond was cleared of leaves and approximately 11,000 larvæ were added. March 22, 9.30 a. m., there were sprayed over the pond 80.69 grams of Paris green mixture. March 22, 3 p. m., some dead larvæ were taken from the pond and dissected. Particles of Paris green were found but the color had changed from bluish green to light green. March 23, 8 a. m., and March 24, 8 a. m., there was still plenty of Paris green on the surface of the pond but one living larva was found near the side of the pond. March 26, 8 a. m., the Paris green mixture was only thinly spread on the surface of the pond and no larvæ were found. The following day Paris green had disappeared and still no larvæ were found. March 29, 8 a. m., a few small larvæ were noticed along the sides of the pond. The following day the water was very clear and again a few small larvæ were found. There were *Anopheles subpictus* (var. *indefinitus*) and were taken at stations 8, 12, and 17. March 31, 8 a. m., a few small larvæ of *Anopheles subpictus* (var. *indefinitus*) were found in dips taken at station 10.

TABLE 6.—*Emergence record of larvæ which pupated soon after the application of charcoal-Paris green mixture on the Bureau of Science pond. (See also Table 4.)*

Date and hour.	Pupæ collected in the pond.	Emerged mosquitoes.		Dead female mosquitoes. [a]	Dead pupæ.
		Male.	Female.		
March 9, 1932, 4 p. m	85				
March 10, 1932, 7.45 a. m		7	10		
March 11, 1932, 10 a. m		32	29	1	6

[a] No dead male mosquitoes were found.

TABLE 7.—*Feeding positions of Culex quinquefasciatus larvæ.*

Date and hour observed.	Larvæ feeding. [a]			Date and hour observed.	Larvæ feeding. [a]		
	At surface.	Sub-surface.	At bottom.		At surface.	Sub-surface.	At bottom.
	Per cent.	*Per cent.*	*Per cent.*		*Per cent.*	*Per cent.*	*Per cent.*
MARCH 31, 1932				*p. m.*			
a. m.				3.50	18	70	12
11.15	9	65	26	APRIL 6, 1932			
11.20	12	76	12	*a. m.*			
11.25	12	84	4	8.35	13	78	9
11.30	14	67	19	8.45	10	83	7
p. m.				8.50	11	86	3
1.55	8	78	14	8.55	11	82	7
2.00	16	67	17	9.00	12	83	5
2.05	14	72	14	9.05	16	73	11
2.10	9	74	17	9.10	13	76	11
2.15	10	78	12	9.15	18	74	8
2.20	17	81	2	9.20	13	85	2
2.25	10	72	18	9.25	18	73	9
2.30	13	71	16	9.30	16	81	3
2.35	11	61	28	9.35	15	79	6
2.40	12	68	20	9.40	21	72	7
2.45	13	66	21	9.45	26	69	5
2.50	8	63	29	9.50	12	75	13
2.55	11	76	13	9.55	16	71	13
3.00	20	72	8	10.00	18	79	3
3.05	21	67	12	10.05	15	78	7
3.10	18	70	12	10.10	16	73	11
3.15	19	69	12	10.15	16	81	3
3.20	18	69	13	10.20	17	77	6
3.25	12	67	21	10.25	23	74	3
3.30	15	60	25	10.30	23	70	7
3.35	12	65	23	10.35	24	68	8
3.40	20	59	21	Average	15	73	12
3.45	18	64	18				

[a] There were 100 larvæ at all times in the pan which had a surface area of 600 square centimeters and a water depth of 3 centimeters.

TABLE 8.—*Feeding position of Culex quinquefasciatus larvæ.*[a]

Date and hour observed.	Larvæ feeding.			
	At surface.	At subsurface.	Deep subsurface.	At bottom.
APRIL 6, 1932	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
p. m.				
12.15	12	78	10	0
12.20	7	69	24	0
12.25	18	76	6	0
12.30	17	80	3	0
12.35	11	78	9	2
12.40	9	91	0	0
12.45	14	77	9	0
12.50	15	77	8	0
12.55	19	73	8	0
1.00	16	76	8	0
APRIL 7, 1932				
a. m.				
8.30	36	56	8	0
8.35	34	63	3	0
8.40	38	60	2	0
8.45	36	60	4	0
8.50	31	68	1	0
8.55	12	64	24	0
9.00	19	75	6	0
9.05	20	70	10	0
9.10	27	67	6	0
9.15	22	72	6	0
9.20	22	69	9	0
9.25	20	64	16	0
9.30	26	67	7	0
9.35	28	68	4	0
9.40	21	66	13	0
9.45	22	61	17	0
9.50	26	60	14	0
9.55	27	62	11	0
10.00	26	61	13	0
10.05	22	63	15	0
10.20	33	56	11	0
10.25	25	61	14	0
10.30	20	76	4	0
10.35	23	64	13	0
10.40	19	60	21	0
10.45	28	68	4	0
10.50	24	63	13	0
10.55	26	64	10	0
11.00	21	62	17	0
11.05	24	76	0	0

[a] There were 100 larvæ in the jar at all times. "At surface" means actually feeding from the surface film. "Subsurface" means feeding in the usual culex manner with siphon at water surface and head hanging down. "Deep subsurface" means about 15 centimeters below the surface. Larvæ were not feeding but exploring. Depth of water in the jar was 56.7 centimeters. Area of water surface was 314.16 square centimeters. Diameter of jar was 20 centimeters.

TABLE 8.—*Feeding position of Culex quinquefasciatus larvæ* [a]—Continued.

Date and hour observed.	Larvæ feeding.			
	At surface.	At subsurface.	Deep subsurface.	At bottom.
APRIL 7, 1932				
a. m.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11.10	26	63	11	0
11.15	20	66	14	0
11.20	22	69	9	0
11.25	28	69	3	0
11.30	22	66	12	0
11.35	28	63	9	0
11.40	15	72	13	0
11.45	21	66	13	0
11.50	18	60	22	0
11.55	23	65	12	0
12.00	17	68	15	0
12.20	9	70	21	0
12.25	8	71	21	0
12.30	10	82	8	0
12.35	12	75	13	0
12.40	11	76	13	0
12.45	10	85	5	0
12.50	16	74	10	0
12.55	9	76	15	0
1.00	11	75	14	0
Average	20.53	68.87	10.57	0.03

[a] There were 100 larvæ in the jar at all times. "At surface" means actually feeding from the surface film. "Subsurface" means feeding in the usual culex manner with siphon at water surface and head hanging down. "Deep subsurface" means about 15 centimeters below the surface. Larvæ were not feeding but exploring. Depth of water in the jar was 56.7 centimeters. Area of water surface was 314.16 square centimeters. Diameter of jar was 20 centimeters.

ILLUSTRATIONS

PLATE 1

Pond at the Bureau of Science where experiments were carried out.

PLATE 2

Type of jars used in experiments showing Paris green-charcoal mixture floating on the surface of the water.

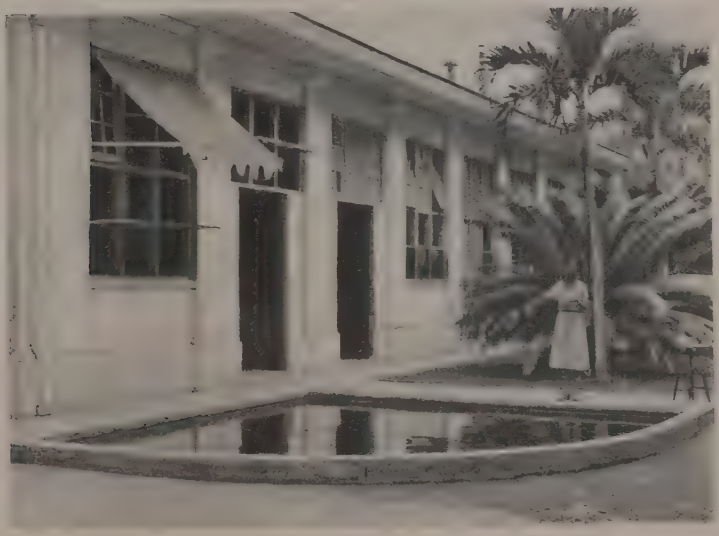
PLATE 3. CULEX QUINQUEFASCIATUS

FIG. 1. Gut of larva after feeding for thirty minutes on a Paris green-charcoal mixture which floated on the surface of the water.
2. Gut of larva after feeding for one hour on a Paris green-charcoal mixture which floated on the surface of the water.
3. Gut of larva after feeding for two hours on a Paris green-charcoal mixture which floated on the surface of the water.
4. Gut of larva after feeding for three hours on a Paris green-charcoal mixture which floated on the surface of the water.

TEXT FIGURE

FIG. 1. *Culex quiquefasciatus; a*, position when feeding at the surface; *b*, pivoting maneuver when feeding at the surface. (Drawn from life by L. Moskaira.)

1



2

PLATE 1.

PLATE 2.

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PLATE 3.

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